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Journal of the Royal Society of Arts.

No. 3,287. VOL. LXIV.

FRIDAY, NOVEMBER 19, 1915.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

ONE-HUNDRED-AND-SIXTY-SECOND SESSION, 1915-1916.

SESSIONAL ARRANGEMENTS.

The Opening Meeting of the One Hundred and Sixty-Second Session was held on Wednesday, November 17th, when an address was delivered by DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council. The subject of the address was, "English and German Methods Contrasted." (See pp. 6-16, below.) The chair was taken at 4.30 p.m.

PAPERS TO BE READ BEFORE CHRISTMAS.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

NOVEMBER 24.—SIR EDWIN PEARS, "Constantinople, Ancient and Modern." COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., will preside.

DECEMBER 1.—THE MASTER OF CHRIST'S COLLEGE, CAMBRIDGE (Arthur Everett Shipley, Sc.D., F.R.S.), "Insects and War." SIR WILLIAM J. COLLINS, K.C.V.O., M.S., F.R.C.S., will preside.

,, 8.—LIEUT.-COLONEL W. A. TILNEY, F.R.G.S., F.R.A.S., late 17th Lancers, "The Art of Finding your Way at Night without a Compass." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

,, 15.—J. JEF. DENYN, Carillonneur de Malines, and WILLIAM W. STARMER, F.R.A.M., "Carillons and Carillon Playing." (With Illustrations.)

COLONIAL SECTION.

Tuesday afternoon at 4.30 p.m. :—

NOVEMBER 30.—SIR SYDNEY OLIVIER, K.C.M.G., late Governor of Jamaica, "Recent Developments in Jamaica: Internal and External." SIR HENRY A. BLAKE, G.C.M.G., will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m. :—

DECEMBER 16.—C. C. McLEOD, President of the London Jute Association, "The Indian Jute Industry." SIR JOHN PRESCOTT HEWETT, G.C.S.I., C.I.E., will preside.

PAPERS TO BE READ AFTER CHRISTMAS.

PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

R. W. SETON-WATSON, D.Litt., "The Balkan Problem."

CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

LAWRENCE CHUBB, "The Common Lands of London: the Story of their Preservation."

REV. P. H. DITCHFIELD, "The England of Shakespeare."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

VICTOR HORTA, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

CHARLES DELCHEVALERIE, "Belgian Literature."

LESLIE URQUHART, "The Economic Development of Russia."

J. ARTHUR HUTTON, Chairman of the British Cotton Growing Association, "The Effect of the War on Cotton Growing in the British Empire."

S. CHARLES PHILLIPS, M.S.C.I., "Paper Supplies as affected by the War."

PROFESSOR T. G. MASARYK, "The Slavonic Peoples."

COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., late Survey of India, "The Romance of the Indian Ordnance Survey."

SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m. :—

January 13, February 17, March 16, April 6, May 18.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m. :—

February 1, March 7, May 2.

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m. :—

WALTER ROSENHAIN, D.Sc., F.R.S., Superintendent, Metallurgy Department, National Physical Laboratory, "Optical Glass." Three Lectures.

LECTURE I.—NOVEMBER 29.—Comparison of optical with ordinary glass—Defects and properties of glass for optical purposes—Transparency—Colour—Bubbles and defects—Striæ or veins—Internal strain and annealing—Hardness and durability—Testing of optical glass—The optical properties of glass—Refraction and dispersion—Their relation in crown and flint glasses—Glasses introduced by Schott and Abbe—Partial dispersions and the secondary spectrum—Apochromatic glasses and lenses.

LECTURE II.—DECEMBER 6.—History of optical glass manufacture—Fraunhofer, Guinand, Feil, Bontemps, Chance—Schott and Abbe—Hopkinson and Stokes—Efforts in England. The present method of optical glass manufacture—The furnace—The pot—Production and treatment—The process of melting and fining—Stirring and finishing—Cooling—Breaking up, selecting and moulding—Annealing—The final form of the glass.

LECTURE III.—DECEMBER 13.—The present process of manufacture—General difficulties—Costliness—Cost of the pot—Time of production—Cost of melting—Raw materials—Low yield of good glass—Risks of the process—Risks of loss during melting—Failures due to striæ—Risks of contamination—Errors and variations of optical constants—Range of glasses demanded by opticians—Small quantities required—Need for large stock of optical glass. Special difficulties in England—Cost of raw materials and of labour—Refractories. Special difficulties connected with "new" glasses—Their chemical activity—Action on pots—Absorption of colouring impurities—Attainment of extreme optical properties. Need for research—The general problem—How to make good optical glass—Necessary improvements in pots and refractories, and in furnaces and methods of working—Utilisation of new materials and electric methods—The special problems relating to individual types of glasses—Optical and other properties to be realised simultaneously—The limitations of possible glasses—Optical properties of crystalline media—Future possibilities.

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m.:—

REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "Flemish Architecture." Three Lectures.

February 7, 14, 21.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

JUVENILE LECTURES.

These Lectures will be given on Wednesday afternoons, January 5 and 12, at 3 p.m. The Lecturer and Subject will be announced later on in the *Journal*.

PROCEEDINGS OF THE SOCIETY.

THE SOCIETY was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom: and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country." In 1908 the Society was granted the privilege of adding "Royal" to its title.

FELLOWSHIP.—At the Annual General Meeting held on June 24th, 1914, a By-Law was made authorising all Members of the Society to use the designation of Fellow.

ORDINARY MEETINGS.—Meetings are held every Wednesday during the Session (November to June), at which papers on subjects relating to inventions, improvements, discoveries, and other matters connected with Arts, Manufactures and Commerce are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with the Indian Empire. Six or more Meetings are held during the Session.

Colonial Section.—This Section was formed in 1874 under the title of the African Section. It was enlarged in 1879, to include the consideration of subjects connected with the Colonies and Dependencies. Four or more Meetings are held during the Session.

Cantor Lectures.—These Lectures originated in 1863, with a bequest by Dr. Cantor. The Lectures deal with the latest applications of Science and Art to practical purposes, and are, as far as possible, experimentally illustrated.

Fothergill Lectures.—Courses of Lectures, similar to the Cantor Lectures, are given from time to time under this bequest.

Howard Lectures.—The bequest of Mr. Thomas Howard (1872) is now devoted to occasional courses of Lectures on motive power and its applications.

Shaw Lectures.—Under the Shaw bequest Lectures on Industrial Hygiene are given from time to time.

Aldred Lecture.—The bequest of the late Dr. Aldred has been devoted to the establishment of an Annual Lecture.

Cobb Lectures.—Funds have been provided for occasional Lectures in memory of the late Mr. Francis Cobb.

Juvenile Lectures.—A Short Course of Lectures, suited for a Juvenile audience, is delivered to the children of Fellows during the Christmas holidays.

Admission to Meetings. — Fellows have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Fellow can admit two friends to the Ordinary and Sectional Meetings, and to the Cantor and other Lectures. Books of tickets for the purpose are supplied, but admission can also be obtained on the personal introduction of a Fellow. For the Juvenile Lectures special tickets are issued.

Journal of the Royal Society of Arts.—The *Journal*, which is sent free to Fellows, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures and Commerce.

Examinations.—Examinations, founded in 1854, are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal elements of Commercial Education and Music. Full particulars of the Examinations can be had on application to the Secretary.

Library and Reading-room.—The Library and Reading-room are open to Fellows, who are also entitled to borrow books.

A History of the Society has lately been published (John Murray, pp. 558, 15*s.* net) and can be obtained from any bookseller. It gives a history of the Society's work from 1754 to 1880.

Conversazioni are held, to which Fellows are invited, each Fellow receiving a card for himself and a lady.

Election of Fellows.—Candidates are proposed by Three Fellows, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid. There is no Entrance Fee.

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1915–1916. It is issued subject to any necessary alterations :—

NOVEMBER, 1915

1	M	
2	Tu	
3	W	
4	Th	
5	F	
6	S	
7	S	
8	M	
9	Tu	
10	W	
11	Th	
12	F	
13	S	
14	S	
15	M	
16	Tu	
17	W	Opening Meeting
18	Th	
19	F	
20	S	
21	S	
22	M	
23	Tu	
24	W	Ordinary Meeting
25	Th	
26	F	
27	S	
28	S	
29	M	Cantor Lecture I. 1
30	Tu	Colonial Section

DECEMBER, 1915

1	W	Ordinary Meeting
2	Th	
3	F	
4	S	
5	S	
6	M	Cantor Lecture I. 2
7	Tu	
8	W	Ordinary Meeting
9	Th	
10	F	
11	S	
12	S	
13	M	Cantor Lecture I. 3
14	Tu	
15	W	Ordinary Meeting
16	Th	Indian Section
17	F	
18	S	
19	S	
20	M	
21	Tu	
22	W	
23	Th	
24	F	
25	S	CHRISTMAS DAY
26	S	
27	M	*Bank Holiday*
28	Tu	
29	W	
30	Th	
31	F	

JANUARY, 1916

1	S	
2	S	
3	M	
4	Tu	
5	W	Juvenile Lecture I.
6	Th	
7	F	
8	S	
9	S	
10	M	
11	Tu	
12	W	Juvenile Lecture II.
13	Th	Indian Section
14	F	
15	S	
16	S	
17	M	
18	Tu	
19	W	Ordinary Meeting
20	Th	
21	F	
22	S	
23	S	
24	M	
25	Tu	
26	W	Ordinary Meeting
27	Th	
28	F	
29	S	
30	S	
31	M	

FEBRUARY, 1916

1	Tu	Colonial Section
2	W	Ordinary Meeting
3	Th	
4	F	
5	S	
6	S	[I. 1
7	M	Fothergill Lecture
8	Tu	
9	W	Ordinary Meeting
10	Th	
11	F	
12	S	
13	S	[I. 2
14	M	Fothergill Lecture
15	Tu	
16	W	Ordinary Meeting
17	Th	Indian Section
18	F	
19	S	
20	S	[I. 3
21	M	Fothergill Lecture
22	Tu	
23	W	Ordinary Meeting
24	Th	
25	F	
26	S	
27	S	
28	M	
29	Tu	

MARCH, 1916

1	W	Ordinary Meeting
2	Th	
3	F	
4	S	
5	S	
6	M	
7	Tu	Colonial Section
8	W	Ordinary Meeting
9	Th	
10	F	
11	S	
12	S	
13	M	
14	Tu	
15	W	Ordinary Meeting
16	Th	Indian Section
17	F	
18	S	
19	S	
20	M	
21	Tu	
22	W	Ordinary Meeting
23	Th	
24	F	
25	S	
26	S	[II. 1
27	M	Fothergill Lecture
28	Tu	
29	W	Ordinary Meeting
30	Th	
31	F	

APRIL, 1916

1	S	
2	S	[II. 2
3	M	Fothergill Lecture
4	Tu	
5	W	Ordinary Meeting
6	Th	Indian Section
7	F	
8	S	
9	S	[II. 3
10	M	Fothergill Lecture
11	Tu	
12	W	Ordinary Meeting
13	Th	
14	F	
15	S	
16	S	
17	M	
18	Tu	
19	W	
20	Th	
21	F	GOOD FRIDAY
22	S	
23	S	EASTER SUNDAY
24	M	*Bank Holiday*
25	Tu	
26	W	
27	Th	
28	F	
29	S	
30	S	

MAY, 1916

1	M	[III. 1 Fothergill Lecture
2	Tu	Colonial Section
3	W	Ordinary Meeting
4	Th	
5	F	
6	S	
7	S	[III. 2
8	M	Fothergill Lecture
9	Tu	
10	W	Ordinary Meeting
11	Th	
12	F	
13	S	
14	S	[III. 3
15	M	Fothergill Lecture
16	Tu	
17	W	Ordinary Meeting
18	Th	Indian Section
19	F	
20	S	
21	S	[III. 4
22	M	Fothergill Lecture
23	Tu	
24	W	Ordinary Meeting
25	Th	
26	F	
27	S	
28	S	
29	M	
30	Tu	
31	W	Ordinary Meeting

JUNE, 1916

1	Th	
2	F	
3	S	
4	S	
5	M	
6	Tu	
7	W	
8	Th	
9	F	
10	S	
11	S	WHIT SUNDAY
12	M	*Bank Holiday*
13	Tu	
14	W	
15	Th	
16	F	
17	S	
18	S	
19	M	
20	Tu	
21	W	
22	Th	
23	F	
24	S	
25	S	
26	M	
27	Tu	
28	W	Annual General Meeting
29	Th	
30	F	

The Cantor Lectures, the Fothergill Lectures, the Ordinary Meetings, and the Meetings of the Indian and Colonial Sections (unless otherwise announced) will commence at Half-past Four o'clock.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Three o'clock.

PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

Wednesday, November 17th, 1915; DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Alexander, Alexander, National Gum and Mica Company, 59th Street and 11th Avenue, New York City, U.S.A.

Ardaseer, J. Grenville, Worli Hill, Bombay, India, and Olney House, Richmond, Surrey.

Audy, Alphonse William, 33, Civil Lines, Poona, India.

Baldwin, Mrs. Edith Brake, 24, Avenue-road, Leamington Spa.

Basu, Narendra Kumar, 99, Upper Circular-road, Calcutta, India.

Bhattacharyya, Jyotischandra, M.A., B.L., Purnea, Bihar, India.

Bhore, Joseph W., B.A., I.C.S. (Diwan of Cochin), Ernakulam, Cochin, South India.

Bloxam, John Astley, F.R.C.S., J.P., The Old Malt House, near Maidenhead, Berks.

Buckley, Edward S., jun., 2039 Sansom-street, Philadelphia, Pa., U.S.A.

Cardona, Joseph M., 1917, Catamarca-street, Rosario, Argentine Republic.

Chance, Clinton Frederick, B.A., 12, Arthur-road, Edgbaston.

Chu Ju, General Chiang Chun Yamen, Chekiang, China.

Clark, The Hon. Sir William Henry, K.C.S.I., C.M.G., Windcliffe, Simla, India.

Davson, Edward R., 20, Ennismore-gardens, S.W.

Dholpur, His Highness the Maharaj Rana of, Dholpur State, India.

Evans, Gerald A., LL.B., J.P., P.O. Box 151, Pietersburg, N. Transvaal, South Africa.

Furness, Horace Howard, jun., 2034, De Lancey-place, Philadelphia, Pa., U.S.A.

Gibbs, A. E., Pennsylvania Salt Manufacturing Company, Greenwich Point, Philadelphia, U.S.A.

Gwalior, Major-General His Highness The Maharaja of (Sir Madho Rao Sindhia Bahadur), G.C.S.I., G.C.V.O., LL.D., A.D.C., Madho Bilas, Sipri, Gwalior, India.

Ingels, Lionel, 5, Grosvenor House, Calcutta, India.

Lambagraon, Lieut.-Colonel the Hon. Raja Jai Chand of, C.S.I., Lambagraon, Kangra District, Punjab, India.

Leech, Arthur John, The Palms, College-road, Madras, India.

Liebert, William Ernest Cato, Messrs. Huttenbach Bros. & Co., Penang, Straits Settlements.

Lord, James Spain, Dover House, Bridge-street, Canterbury.

McCorry, Joseph James, 73, University-avenue, Belfast.

Miln, David Anderson, LL.B., M.A. (Edin.), 30, Greencroft-gardens, South Hampstead, N.W.

Mitchell, Alfred H., M.I.Mech.E., Port of London Authority, Elevator Dock, Silvertown, E.

Musgrave, Henry Arthur Fitzherbert, United Service Club, Calcutta, India.

Naidu, P. N. Muthuswami, B.A., Pagadala Bagh, Saidapet, Madras, India.

O'Callaghan, Major-General Sir Desmond D. T., R.A., K.C.V.O., 53, Iverna-court, Kensington, W.

Pite, Professor Arthur Beresford, F.R.I.B.A., 21, Willow-road, Hampstead, N.W.

Renult, William, 141, Broadway, New York City, U.S.A.

Showers, St. George, 32, Elm Park-road, S.W.

Singh (of Kapurthala), Sirdar Charanjit, Chadwick, Simla, India.

Singh, Rai Bahadur Choudri Amar, P.O. Pali, Dist. Bulandshare, United Provinces, India.

Smith, Alexander, 21, Oakshaw-street, Paisley, Scotland.

Smith, Lieut.-Colonel Thomas, V.D., The Muir Mills Co., Ltd., Cawnpore, India.

Sundaracharlu, S. K., M.A., Tahsildar, Tindivanam, South India.

Thorne, Mathew Henry, Rua Padrão, Vallongo, Portugal.

Vanderlip, Frank Arthur, A.M., LL.D., National City Bank, New York City, U.S.A.

The CHAIRMAN delivered the following

ADDRESS.

The Royal Society of Arts, to which we have the honour to belong, now enters upon the 162nd year of its existence in the culminating stage of the greatest war the world has yet seen. Our Society has had a long, useful and distinguished career, and it is our duty, as its present members, to see to it that its power for good is maintained and its beneficent course continued to aid a future England, as it has undoubtedly assisted the England of the past. Our Society is a characteristically English institution, and its proceedings faithfully reflect the numerous incidents of the progress of our Empire through the dawn and rise of industrial civilisation. All the great matters of national, Imperial, and industrial development are to be found fully discussed in our Proceedings for more than a century and a half.

In ordinary times your Chairman addressed you on matters in the field in which he had won his reputation. I propose to deviate from this course, and so avoid inflicting upon you a technical engineering address on gaseous explosions and the internal-combustion engine.

It seems to me more appropriate in these stirring and critical times to reflect the current of all our thoughts, and to express my appreciation of the high honour of acting as your Chairman by attempting a defence of England's position under the title of "English and German Methods Contrasted."

Friends and foes agree as to England's success, but find great difficulty in understanding the reason why.

Our friends see in our proceedings a lack of order and method, and attribute our position in the world to a large extent to our good fortune in being early in the field; we became, they think, the first of the world's industrial nations by a happy combination of circumstances independently of any particular qualities of our own. This is evident from the expressions used by friendly nationalities towards England and Englishmen.

One able writer of foreign extraction, in a recent article, refers to England as "unpractical, illogical, idealistic, laughing England." Another speaks of England's extraordinary facility for "muddling through." Our enemies, the Germans, while agreeing that England has built up a mighty empire, "which is the object of all policy," assert that this has been accomplished with a complete disregard of political morality.

Bernhardi says: "We must not deceive ourselves as to the principles of this English policy. We must realise to ourselves that it is guided exclusively by unscrupulous selfishness, that it shrinks from no means of accomplishing its aims, and thus shows admirable diplomatic skill." Bernhardi's idea is in opposition to the friendly view, and is shared by numerous enemy writers.

Our own Professor Seeley, in his great work on "The Expansion of England," makes the much quoted statement: "We seem, as it were, to have conquered and peopled half the world in a fit of absence of mind."

We ourselves know that we have built up a world civilisation, but doubt grievously as to its lasting power. Some business men even consider our commercial ruin as imminent. Mr. Chamberlain predicted this as our fate in 1903. Even in 1915, we are assured by many of our professor friends that unless we organise we shall become bankrupt in a few years, victims to the superior systems of Germany and America. German methods especially are extolled as worthy of our imitation, and they are continually contrasted with English, greatly to our disadvantage. The German methods are stated to be scientific, accurate and far-sighted; the English, amateurish, inaccurate and short-sighted.

Professor Unwin and Dr. Hele-Shaw, in recent addresses, expressed themselves as much impressed by the fact that Germany's output of pig iron and steel is now nearly double that of England. Professor Unwin says: "Although Germany has on the whole poorer qualities of iron ore and coal, her production of pig iron has increased from 11,000,000 to 19,000,000 tons annually, while ours increased only from 9,000,000 to 11,000,000 tons. To-day her production of steel is nearly twice as great as ours." Dr. Hele-Shaw also calls attention to Germany's increased steel production, and he evidently fears the competition of Germany after the war. He states: "As I have already quoted, Germany's power in war is admitted to be her mechanical organisation, and the organisation of every material and engineering force to that end. Just as striking, if not more so, is her organisation for the arts of peace, and I lately heard a very shrewd man of affairs express his amazement at Germany's entrance into war, when by peacefully pursuing the way she was going she would have dominated the world commercially in a few years' time, and, in the words of the speaker, might in many manufactures have made us practically bankrupt. It is undoubtedly in the matter of scientific organisation even more than the organisation of science that Germany has achieved such wonderful results, and it is therefore in this direction that we must leave no stone unturned if we wish to have any chance of holding our own in the future." Those two distinguished engineers obviously think our country in a bad way.

The chemists, too, are of the same opinion. In this very hall Lord Moulton has said: "After the war, if we do not effect a change, the textile industries would step into a slavery to the Germans as great as that in which they hope to put us in a political and military sense." Dr. Foster, the treasurer of the Chemical Society, has also said: "The Germans are so imbued with the need of pursuing modern and efficient methods of education, in applying science to industry, that they hold in contempt a country which notoriously neglects such processes."

English methods are called in question also by literary men, politicians, and even an Admiral.

In the late Professor Cramb's most interesting work, "Germany and England," is found the following. Speaking of Germany, he says: "From Austria and from France she had endured insult upon insult, measureless humiliations. But from England?

"England's possessions, England's arrogance on the seas, her claim to world-wide empire—these, Germany answers, are to Germany an insult not less humiliating than any she has met with in her past. And what are these English pretensions? And upon what are they based? Not upon England's supremacy in character or intellect. For what is the character of this race which thus possesses a fifth of the habitable globe and stands for ever in the path of Germany's course towards her 'place in the sun,' in the path of Germany's course towards empire? . . . England's supremacy is an unreality, her political power is as hollow as her moral virtues, the one an arrogance and pretence, the other hypocrisy. She cannot long maintain that baseless supremacy. On the sea she is being rapidly approached by other Powers; her resources, except by immigration, are almost stationary, and her very immigration debases still further her resources. Her decline is certain. There may be no war. The display of power may be enough, and England, after 1900, like Venice after 1500, will gradually atrophy, sunk in torpor." This, Professor Cramb states, is the German indictment of England.

His own view is thus given: "When, turning to England, I consider the apathy or the stolid indifference of the nation—when, for instance, I consider the deliberate and hostile silence or loud calumnies which, for the past seven years, have accompanied Lord Roberts's crusade; and when, over against this apathy, I survey in this month of February, 1913, the energy, the single devoted purposefulness throbbing everywhere throughout Germany, her forward-ranging effort, her inner life, her army, her fleet, I seem to hear again the thunder of the footsteps of a great host. . . . It is the war bands of Alaric!"

Professor Cramb obviously did not approve of the methods of his countrymen.

Politicians also bring this charge of apathy, and frequently exhort England and its men of business to "wake up."

One would have thought that at least our Navy was sound, but we are informed by Lord Charles Beresford, in a remarkable book entitled "The Betrayal," published in 1912, that even there no safety is to be found. This book is an indictment of the entire Navy, as to its organisation, ships, and officers. The very titles of the chapters are alarming. Take, for example, "Ships without Docks," "The Delusion of the 'Dreadnought' Policy," "The Fraud on the Public," "How Not to Do it," and so on.

Lord Charles Beresford alludes to the great North Sea concentration as the "scrapping policy." He objects to the whole principle of the "Dreadnoughts," and considers their building only led the British public into a delusion, from which they were still suffering in 1912, and one objection he makes is sufficiently surprising: "In 1906 the tradition of dignity and courtesy hitherto prevailing in the Service was rudely violated, and Great Britain proclaimed herself the Bully of the Seas."

He objects to the "Dreadnoughts" for a singular reason: "The British traditional policy was reversed in another respect. Hitherto it had been our practice to keep so powerful a margin of strength in ships that we could afford to await the result of the experiments of other Powers. In due time, when it became clear what our requirements with regard to other Powers were, we proceeded to fulfil them."

According to Lord Charles Beresford, in building the "Dreadnought" the Admiralty boasted that we led the world, and this statement, he says, was false.

In another part of the book, speaking of the Home Fleet, he states: "I said privately at the time, and I say publicly now, that the Home Fleet was a fraud on the public and a danger to the State."

Engineers, chemists, literary men, politicians, and an Admiral, have all protested in effect the inferiority of our methods and the superiority of the German. According to this school of thought we can only be saved from national, industrial, and scientific extinction by humbly following the German lead, and copying her institutions as closely as our limited intelligence permits.

Now, is all this true? Is German success so great and ours so small? How do we compare with Germany in peace and in war?

It is quite true that Germans now manufacture more steel per annum than we do. It is true that they supplied us with dyes for use in our textile industries. It is true that they organised industry for the purpose of raising prices, and carried out the Kartell system, so as to produce powerful combinations of separate business organisations, such as the Rhenish Westphalian Coal Kartell, the Westphalian Coke Kartell, the Wire Kartell, and syndicates also of the pig-iron, the half-finished iron and steel.

It is true that for many years they have directed their organisations to the purpose of war, and inspired their whole people with a hatred of England, because of the insult of our world-wide Empire, and the annoying universality of the English flag upon the seas of the world.

It is true that Lord Fisher effected the great North Sea concentration of our Fleet; it is true that England designed the "Dreadnought" type of battleship, and invented numberless mechanisms to make it a success; and it is true that some of our politicians, in the heat of argument, carried their dissensions to such intensity as to encourage the Kaiser in vain hopes; but it is not true that these facts, looked at in their proper light, in any way shew England's methods to be unsuccessful or England's position to be unsafe in the world.

In times of peace nations must depend one upon the other for products which each is particularly suited to produce. It is misleading, for example, to cite the relative production of pig-iron and steel as proving either the prosperity of Germany or the decadence of England. A very slight examination shows this to be so. The United Kingdom, for example, has a total of 23,417 miles of railway, and an area, roughly, of 121,000 square miles. Germany has now 37,949 miles of railway, and an area of 242,867 square miles. Germany has abundant store of ores, fit for reduction by the basic steel process—the invention of English metallurgists, Thomas and Gilchrist—and it would indeed be extraordinary if a capable and industrious nation such as the Germans are, with all their faults, could not succeed in making most of the steel required for their own uses. It is obvious, from the most cursory glance at German exports and imports, that the greater quantity of steel made by her is used at home. We do not hear anything of the relative decadence of Germany as compared with America, and yet the American production of steel exceeds the German in nearly the same ratio as Germany exceeds England. The reason for the greater production in America is the same, that American railways again exceed in mileage the German. The area of the United States is, roughly, 3,571,223 square miles, and the railways are 246,573 miles. Notwithstanding this enormous production of steel in both Germany and America, steel exports do not form a large proportion of the total of either country.

Again, while our chemists can point to the German predominance in dyes, England can point to whole districts of Germany which depend for the prosperity of their textile mills upon yarn spun in Lancashire and upon machinery made there. At the present moment these industries are brought to an absolute standstill by the lack of English yarn. Germans might well use Lord Moulton's words, and say that the German industries are under the same tyranny which England holds over the world, by what they are pleased to call the lack of freedom of the seas. Quite a number of German industries absolutely depend on England for their success.

If comparative magnitude of industries is to be taken as the standard of success, then England can point to her shipbuilding, marine engineering, her ocean carrying trade, her cotton and woollen textile industries, her huge coal-mining industry, and others in which she is supreme in the world.

Take shipbuilding for example. In the year 1911, the United Kingdom built 69 per cent., and Germany only 9·7 per cent., of all the vessels launched in the world during that year. Germany's shipbuilding thus only amounted to about one-seventh that of Britain. In the same year the United Kingdom owned 46 per cent. of the total sea tonnage of the world, and Germany 11 per cent., less than one-fourth of Britain. Shipbuilding naturally varies considerably with the demand, but Britain builds on an average about 60 per cent. of the world's output in each year. Many of these ships are built for other nations, including Germany, but nevertheless British-owned shipping remains supreme in tonnage, quality, and capability of the vessels comprising our mercantile fleet. Naturally, as our shipbuilding and shipping output leads all others, our marine engineering industry is also much the greatest in the world.

In the textile industries, too, we are supreme. This can be most easily seen by comparing the numbers of the world's cotton spindles at a recent date. In 1912, our mills in the United Kingdom contained 55,165,000 spindles. Germany, Austria-Hungary, Italy, Russia and France, only contained among them 36,139,000 spindles. Practically the whole continent of Europe thus only contained less than three-fourths of our spindles. The United States mills contained 29,523,000 spindles.

Now with regard to coal production. In 1911, the coal-mining industry of the United Kingdom raised 271·9 million tons; Germany, 158·2 million tons; and the United States, 443 million tons. The United States is thus the greatest coal-producing country in the world; Britain comes second, and Germany third.

Compared to Germany by the magnitude standard, Britain, from these figures, must be considered superior. The intensity of industrial effort, however, in different countries is measured best by the actual consumption of coal per head of the population of each country. In the same year, the United States consumed 4·54 tons per head, the United Kingdom 4·08 tons, and Germany 2·03 tons. These figures show clearly that America and England have reached a higher stage of industrial civilisation than Germany. The larger coal consumption shows that America and England require greater motive power and greater use of fuel for metallurgical and other processes than Germany.

These examples deal only with a few industries, and it may be argued by the upholders of Germany that, notwithstanding our supremacy in some, yet on the whole British industry is out-distanced by the German. Such a statement can be tested by comparing the total external trade of the countries one with another, that is, the imports plus the exports. In 1911, the total external trade of the United Kingdom was £1,031,000,000; the German, £807,000,000; and the United States of America, £671,000,000. In 1912, the British total external trade rose to £1,344,000,000. The German and American figures are not yet available, but it is certain that in total trade England remains well in advance of Germany.

Another test of the success of a nation is to be found in the difference between imports and exports. In a highly successful nation, the imports are always greater in money value than the exports, and the difference between imports and exports indicates the earnings of the country from foreign nations by means of shipping, banking, engineering design, and investments in foreign undertakings.

In time of peace, the excess of imports represents the payment to the British for services rendered outside of the export of goods in that particular year, and the sum naturally varies from year to year, and is greater over a series of years in Britain than in any other country. England is the great creditor nation of the world.

Tried in all these ways, industrial England must be considered as highly successful; but no country can be deemed really successful nationally unless it contrives to supply its people with sufficient food, for physical efficiency, comfortable clothing, and suitable housing. Physical comfort can best be judged by considering the income of the nation per head of the population, and in considering this adopting a standard of rea income—that is, income in terms of the things required for subsistence and comfort which we can afford to get. Tested in this way, Germany compared to England is a poor country. Her average income per head of the population is but little more than half ours. Before the war, the total income of the United Kingdom was about £2,400,000,000, or £53 per head per annum of our population. The German figure is something like £30 per head. Even Bernhardi admits the superior prosperity of England from this point of view, although he deals with a more elusive figure than income, viz., that of capital. He states that throughout the German Empire the capital in 1911 was between 5,000 and 6,000 Marks per head of the population. He credits England with 6,000 to 7,000 Marks per head. Capital value, however, is not in my view so reliable for our purpose as total income. The income gives the actual working wealth capable of application in various ways. The capital is so much of it fixed that there is no possibility of changing or liquidating so as to apply to any other than one purpose. Without doubt, the average Englishman, from the physical comfort standpoint, is much better situated than the average German. His wages are higher, his food is cheaper, his housing is better, and his hours of labour are shorter than the German's. He has a better chance of improving himself physically and intellectually.

Whatever then be the German organisation for the arts of peace, and whatever be our lack of method or organisation, all tests which can be applied show the English as a nation to have attained greatly superior results as compared with Germany.

We are particularly characterised as unscientific in our methods. It is difficult to see exactly what is meant by this statement, but many of our professors continually proclaim, like Dr. Foster, our national neglect of science, especially in its application to industry.

An examination of the leading scientific work of England shows that it is always brilliant, far-reaching, and early in the field. Practically all fundamental discoveries in science have originated in England, France, or Italy. Germany's scientific work is undoubtedly of an important kind, but it is always of what may be called the "pedestrian" type; hard-working and plodding, but with little foresight or brilliancy.

The scientific discoveries of England in the

nineteenth century are numerous. For example, in the domain of heat, the whole science of thermodynamics was originated and worked out between France and England. One of the two great fundamental discoveries in thermodynamics, the Carnot cycle, was made in France early in the nineteenth century; the fundamental work of Joule, of Manchester, determined the other, the mechanical equivalent of heat, about 1840; and the subsequent work of MacQuorn Rankine and Lord Kelvin in England co-ordinated Carnot's and Joule's discoveries, and produced the two great thermodynamic laws—the first, the mechanical equivalent of heat, and the second, the limitation of heat conversion into work depending upon the temperature of source and the temperature of discharge.

The German physicists Meyer and Clausius also did good work, but its importance was secondary compared to that of the English investigators.

In electricity also the greatest discoveries fall to England. Faraday's discovery of the production of electric currents by motion of a conductor in a magnetic field was one of the most fundamental and far-reaching ever made. All subsequent work resulting in the production of the dynamo and electric motor, and the huge power and lighting electrical developments of to-day, flowed from Faraday's discovery made at the Royal Institution in Albemarle Street, London.

In the theory of light also, work of fundamental importance was due to English physicists from Thomas Young to Clerk-Maxwell and Poynting. Clerk-Maxwell's electromagnetic theory of light was used in predicting the existence of ether waves travelling through space at the same velocity as light, but with wave-lengths incomparably greater. Clerk-Maxwell's work, in fact, suggested wireless telegraphy. It is true that Hertz, a German, and an able experimenter, was the first to design apparatus whereby what is called the "wireless wave" could be sent through a short space and detected, but Hertz's work could not have existed without the prior work of Clerk-Maxwell.

The work of Sir William Crookes also, and his study of the various phenomena of electrical discharge in high vacua, disclosed effects hitherto unsuspected, and enabled him to produce rays within an evacuated bulb which could be caused to act upon the molecules so as to make them bombard pieces of metal and refractory material placed within the bulbs, the material being actually rendered incandescent by the bombardment of the invisible molecules. Crookes' work suggested developments which were taken up in Germany, and one result was the discovery of Röntgen's rays. Röntgen, a German, is a man of scientific merit without doubt, but he followed Crookes—he did not lead him. Another wonderful discovery of Sir William Crookes led to the radiometer, and this led to other discoveries made by both English and Continental scientific men.

England, too, was first in the investigation of liquefied air, hydrogen, and other gases. It is true that the French physicist, Cailletet, had previously liquefied air on a very small scale within a tube, but it remained without effect upon our knowledge of low temperatures until Sir James Dewar, by designing and installing large apparatus, succeeded in producing liquid air at a temperature below its boiling-point, so that it could be poured from vessel to vessel in the open atmosphere. A whole series of interesting discoveries were made by Sir James Dewar and his English and Continental followers in connection with low temperatures.

The work of Clerk-Maxwell, Crookes, and Dewar led to discoveries as to the nature of the atom, and this subject was taken up in the most brilliant manner by Sir J. J. Thomson. From his work a whole new science has sprung, and the twentieth century may be hereafter known as the century of the atom and the molecule.

The names of Sir William Huggins and Sir Norman Lockyer show that England has not neglected solar and stellar spectroscopic research.

Atomic and molecular knowledge has increased notably since the discovery of radium. Originally radio-activity was discovered by a French physicist, Becquerel. Professor and Madame Curie, working on the known fact of the radioactivity of certain ores, succeeded in concentrating the part to which this peculiar property was due, and produced radium bromide. To the French is due this brilliant discovery; but to the English investigators, Professor Rutherford of Manchester, Professor Bragg of Leeds, Professor Strutt of London, and Professor Soddy of Glasgow, is due the wonderful modern development which gives a complete history of atomic disintegration and enables us to realise the enormous energy stored up in the atom. Bragg's work, too, upon the structure of the crystal, as determined by the X-rays, brilliantly follows up the other recent knowledge.

In scientific chemical discovery we have not been behind, as is proved by the mere mention

of the great English names: John Dalton, Humphry Davy, Michael Faraday, Thomas Graham, Thomas Andrews, William Robert Grove, Edward Frankland, William Crookes, and William Henry Perkin, which at once call to mind the great fundamental matters; the atomic theory; the electrolytic decomposition of the alkalies; nitro-benzole; gaseous diffusion; critical temperatures of gases; the gas battery; thallium; and aniline dyes. The work of Lord Rayleigh and Sir William Ramsay resulted in the discovery of argon, a gas which had been hinted of as existing in the atmosphere more than a hundred years ago by Cavendish. The discovery, too, of helium as a decomposition product from radium emanations by Ramsay is one of the first importance.

In biology also English scientific men take a leading place. Darwin was a man of a century, and the mass of biological investigation at present in progress in England is surpassed in its results by no German work.

In pure science, whatever opinion may be held as to our methods, our results greatly surpass those of Germany.

The invention of England, too, is more important than that of Germany. English inventors created the steam-engine, applied it first to pumping, then to factories, and later to marine propulsion and railway locomotives. All the great steam inventions of the past 150 years have been English, or rather, British—separate condenser, high-pressure, expansion, compounding, tripling, and, last of all, the greatest steam invention since the time of James Watt, the steam turbine, all purely British.

In electricity, too, England has taken a most important part in the development of Faraday's discovery; the magneto, the dynamo, and the investigation of the fundamental laws of dynamo and motor, are all English.

The incandescent electric lamp was the simultaneous production of the Englishman, Swan, and the American, Edison.

Telegraphy, too, has been largely developed in England. The inventions of Lord Kelvin, the mirror-galvanometer, the syphon recorder, and his studies of induction in submarine cables, made transatlantic telegraphy possible. The modern developments in transatlantic telegraphy are also English. The invention of Mr. Sydney Brown enabled the syphon recorder to be modified so as to print in type in the same manner as an ordinary receiving printing instrument.

In wireless telegraphy, too, the first application of the work of Clerk-Maxwell in England and of Hertz in Germany was made by Sir Oliver Lodge, and his discoveries form the basis of much of the successful wireless telegraphy of the world. The brilliant Italian, Marconi, of Italian and British parentage, by his genius perfected the wireless telegraphic methods in such a way as to combine physics with engineering, and sent messages across the sea in some cases to the enormous distance of 6,000 miles. Marconi carried out the most of his work in England with the assistance of English physicists and engineers.

In the application of the science of thermodynamics to both the steam and internal-combustion engines, England has taken a leading part. Our committees and investigators have been most energetic.

England was early in the field in internal-combustion engineering work. Professor Farish (1817), the Rev. William Cecil (1820), and Samuel Brown (1823), followed by a long line of inventors, have worked conscientiously and successfully in developing both steam and internal-combustion engines to make them fit for the great modern purposes of driving fixed machinery, motor-cars, and aircraft. In this work it is true America led with the flying machine, by Professor Langley's brilliant work resulting ultimately in the successful application of the internal-combustion engine to flight by the brothers Wright.

By the work of the Advisory Committee on Aeronautics, the National Physical Laboratory, and the Government Aircraft Factory, acting in combination with private firms and inventors, most successful aeroplanes have been produced, and the superiority of the British aeroplane has been distinctly proved in the present war.

England, too, has been most fortunate in her great societies and institutions for the advancement of scientific knowledge, industrial knowledge, and the application of such knowledge to the general purposes of civilisation. The oldest of these great and useful institutions is the Royal Society, instituted in 1662. Next is the Royal Society of Arts, dating from 1754, now beginning its one hundred and sixty-second session; followed by the Royal Institution, established in 1800. The great technical institutions also are the Institution of Civil Engineers, established January, 1818, and the Institution of Mechanical Engineers, established 1847. The discoveries made by the Fellows of the Royal Society and by the professors of the Royal Institution are unrivalled in the world. The

application of science to our industries has been and now is very substantially advanced by the activity of our own society. The Royal Society of Arts and our two great engineering institutions have accomplished great things. No German institutions approach these in influence for good.

In all this there is no sign whatever of any lack of application of science to industry. In industry, in the attainment of comfort and science and invention we are alike successful. Germany is also successful because she shares the results with ourselves of the work of the whole world, but she shows no signs of success in the least likely to overcloud England. Our professors, in my view, are entirely mistaken. They see a successful Germany; they imagine her more successful than she is. They see an unsuccessful England simply because they have failed to take a broad view of the whole position. Tested by results, England is successful both in industry, science, and invention.

The inevitable conclusion we arrive at is that England compares to great advantage with Germany in all the arts of peace.

How do we compare in war?

England has in the past been engaged in many wars. The result is evident in our huge Empire, the greatest which the world has ever seen; great sister dominions governing themselves, controlling huge tracts of country, and having populations of British and their descendants of about 16 millions external to these islands. We also have Crown Colonies and huge Dependencies, such as India, Ceylon; Protectorates, such as Egypt. In fact, the British Empire exists in Europe, Asia, Africa, America, and Australasia, with a population of more than 400 millions, and a total area of over 13,000,000 square miles.

British methods of governing have hitherto enabled us to maintain this huge Empire in security with a total army of about 700,000 men all told, including territorials and reserves. The geographical fact of the British being an island race led to an empire spread over the seas of the world, and made it necessary to maintain a great fleet.

Our small army provoked German contempt; our fleet, German admiration and rivalry.

German reasoning is very curious. They thought that a nation with so small an army had no right to exercise dominion over one-fifth of the world. They felt strongly that right could only exist when accompanied by huge physical power in the shape of a great military system. The freedom of our colonies and our dependencies was entirely misunderstood by them. They felt that all were longing to liberate themselves from the British yoke. They thought that at the first breath of war Australia, Canada, New Zealand and South Africa would rebel, and that India would rise against our small army and annihilate it. They failed to understand that the freedom of the governed formed an essential part of the British method of ruling. In these islands, in her colonies and in her dependencies government was so arranged by England as to reduce interference with the liberties of the people to the absolute minimum. Governing was always arranged as part of the English system in the interests of the governed. The portion of the world ruled from England experienced prosperity such as had never been known before. Accordingly, when the great war broke upon us last year, Germans were astounded to find that from all the world over help in men, money and munitions was at once lavishly forthcoming. Australia, Canada and New Zealand sent strong contingents of their best men. India and Indian princes were eager to fight for England. Only in South Africa did Germany succeed in raising a comparatively insignificant rebellion; and even here they were astounded to find that Britain withdrew all her troops and left General Botha with his loyal followers to deal with their domestic concerns. The result we have seen. Not only did the rebellion subside in the Commonwealth of South Africa, but the South Africans themselves vigorously proceeded against German South-West Africa, and speedily reduced it to subjection.

Whatever England's moral virtues are, her supremacy has proved to be anything but an unreality. Whatever her moral virtues are, her political power has proved to be anything but an arrogance and a pretence. The German idea of the British position proved to be absolutely wrong.

The German rivalry in fleet building lasted for many years, but England followed improvement with improvement; a continuous increase in tonnage of our war vessels, stronger armour, larger guns and enormously increased motive power. Strain as the Germans might with all their science and method, they utterly failed to keep pace with Britain. When they were building battleships with 11-inch guns, ours had 12-inch; when they attained to 12-inch we had 13½-inch; and when they attained to 14-inch guns we presented them with a fleet

having 15-inch guns. At first Germany tried to persuade herself that her smaller guns were superior to the larger British, and that in some way her mechanism was better and her sailors more completely trained. In motive power as well as guns and ships they also followed England. Sir Charles Parsons succeeded in applying the steam-turbine to ships in 1897. The English Admiralty soon came to the conclusion that battleships not only required powerful armour and large guns, but higher speeds than were obtainable by reciprocating engines. The Parsons turbine gave power within limits of weight which made very high speeds possible. Accordingly England had battleships with over a million horse-power in steam-turbines afloat before the slow movement of the German brain grasped the fact that turbines were better than reciprocating engines.

This was also true of our merchant fleet. England had about half a million horse-power in steam-turbines aboard her merchant fleet before the Germans had a single merchant turbine vessel. Germany signally failed to keep pace either with shipbuilding, guns, armour, or engines as found in the British fleet.

Before the war, because of such utterances as those of Lord Charles Beresford, many doubted the power of the British fleet, and Germany often proclaimed it over-rated, and even German officers drank to "The Day" when the battleships of Britain and Germany would meet in the final great trial. After fifteen months of war the relative positions of Germany and Britain in the world prove the overwhelming strength of the British fleet; the German battle fleet locked up in the Baltic and the Kiel Canal; the German mercantile fleet swept entirely off the seas; no single German cruiser afloat to harass British commerce; the British flag supreme upon the seas; and British commerce proceeding in its normal manner in all the seas of the world. The German admission of Britain's overwhelming strength is here complete. They do not share Lord Charles Beresford's views as to the illusion of the "Dreadnought" policy, although they may agree with him that Great Britain has become, so far as Germany is concerned, the "Bully of the Seas."

The British navy is as efficient in her battle cruisers, light cruisers, torpedo destroyers and submarines as she is in the battle fleet. Contrary to the idea assiduously circulated by Germany, Britain took the lead in submarine construction, and at the beginning of the war Britain possessed many times the number of submarines existing in the German navy. Britain's torpedoes, too, were of a very powerful and efficient type, developed—again in Britain—by British officers of the Royal Naval Torpedo Factory to a power and speed greatly in excess of those of the German torpedoes. Undoubtedly in war our naval results are superior to those of Germany.

With regard to the army, Germans failed to see that, given a sufficiently powerful navy, Great Britain had ample time to produce a numerous and powerful army. It is true that at first Britain had prepared only a small army; and at first, as Mr. Asquith has said, she sent over to the Continent in a few weeks some six divisions—about 120,000 men; but in doing this she amply fulfilled all her promises to her Allies. It speedily became evident, however, that the Allies stood in need of greater assistance than this; but the difficulty arose, not because of any defect in Britain's preparations or in the fulfilment of British promises, but on account of unexpected difficulties found by our gallant Allies in developing their full strength. British resource and elasticity enabled us to go rapidly to their assistance; and now, as Mr. Asquith has told us, Field-Marshal Sir John French has nearly one million men fighting on the western front, and we have large armies, safely transported by our ships and protected by our cruisers, in the East, all fighting vigorously.

Britain is successful, even on the military side, to a degree which surprises Germany.

So far Germany has been entirely unsuccessful. It is only necessary to glance at the extracts reaching England from the German papers in the early days of the war and to read Bernhardi's work to see how different this war is from that planned by the German Emperor and his great General Staff. The original idea undoubtedly was rapidly to overwhelm France by violating the neutrality of Belgium, and then to turn on Russia before she had time to mobilise fully. The German idea was definite on this point, and Bernhardi lays special emphasis on the rapidity of movement. "France," he says, "must be so completely crushed that she can never again come across our path." Six months seemed to be the extreme period set by them for this work. Britain was not intended to fight at all, and the British intervention, by Britain's secure grip on the seas, nullified all Germany's elaborate preparations.

Germany has lost millions of men and has not succeeded in one of her objectives. Even at the present moment England is successful in war; we have only to exercise patience and stand firm

to see the final collapse of the enemy. In war, as in peace, judged by success, England's methods are not inferior to those of Germany.

Why, then, does Germany, with its order and method, fail in war, while "unpractical, illogical, idealistic England" is successful?

The cause, I believe, is to be found deep down in the nature of the respective peoples. The German brain is, according to Buckle, deductive, while the English brain is inductive. All German philosophers have invariably been of the deductive type, while among English philosophers only Newton and Harvey are deductive. Practically all others are inductive. The deductive brain, allied to stupidity and a curious irrelevance, is characteristically German, and often produces absurd results. Even when legitimately used the deductive system is dangerous. It looks far more orderly and brilliant to deduce a whole universe from a few general propositions, but in actual life it is much safer and more accurate to rise from the particular to the general rather than to descend from the general to the particular. Darwin's brain was essentially inductive. He amassed numerous facts; he reasoned at short range from those facts, and ultimately established general propositions after much study and examination of apparently trifling matters. The inductive system treats formal logic with contempt, and this is characteristic of the English intellect. In science Faraday was eminently inductive. He always accumulated a great mass of experimental facts, and reasoned from them at short range to some general principle which he found underlying all the facts.

The inductive method may be said to be essentially an experimental method. English inventors have been almost invariably inductive. James Watt and his colleagues produced splendid and powerful steam-engines, working with an economy admirable for the time, without a knowledge of the mechanical theory of heat. No professor or scientific man could have given them that knowledge, because it did not spring into existence during Watt's lifetime. Notwithstanding ignorance of the great general principles, by diligent experiment, reasoning from experiment close to his facts, and summing up all his reasons, he developed on true lines. The science of thermodynamics did not create the steam-engine. On the contrary, it may be truly said that that science originated in the study of steam motive power.

English science is still essentially inductive, although after a certain stage induction and deduction are powerful aids one to the other. The inductive method looks disorderly. It is a method of trial and error, but more solid knowledge has been gained by its use. It looks unmethodical because the mind is confused by a multitude of facts. Ultimately, however, after sufficient care has been devoted to the study of the facts, it becomes methodical in a safe manner. The inductive method is a method particularly suited to the limitations of the human brain. The deductive method requires an accuracy of postulate or premises in most cases beyond the range of the human intellect. In some cases the method gives brilliant results, as in Adam Smith's treatment of "The Wealth of Nations" and Poincaré's treatment of the "Theory of Explanation."

Mathematical studies deal eminently in deduction, but most practical affairs, although guided by mathematical considerations, are too complicated to be fully treated mathematically. Some simplification is always necessary before it is possible to find a formula to fit the usual complication of facts occurring in engineering. Continental mathematicians and physicists always smiled while they admired the inductive intellect of Lord Kelvin, who at one time said that he never considered he understood a theory unless he could make a model illustrating its action. This making a model of everything is characteristically English, and safe. The model permits us to see incongruities and departures from simple theory. The deductive intellect tries to strain matters—and, indeed, human affairs—into a rigid frame, granting only general propositions and deducing all the rest from these. The Germans as a nation always tried to do this. They must have formal order. They must think out a complete system, all the parts flowing one from the other, all co-operating in different ways to produce the desired result.

The whole German nation is moulded upon the military idea of power and the rights of nations determined by power alone. It is a simple-minded and foolish idea, which entirely misses the unknown occurrences and forces easily discovered by inductive methods. It gives an apparent simplicity and order to real disorder. Life is infinitely complex, and the human intellect is too feeble to grasp all life in one simple ordered sequence. Germans attempt this and they fail. The English realise the truth. They have no illusion about the mightiness of their intellect. They do not say, as a German says, "This should, or must, act in this way"; they ask, "Here are circumstances; what is

really happening ?" They observe the circumstances, and they deal with occurrences largely as they present themselves. The English always grasp, however, in war as in peace, the essentials which must be observed if failure is to be avoided. The Germans sometimes succeed in their ordered sequence, but Nature interferes most rudely and prevents the accomplishment of things which German reason proves absolutely to its own satisfaction should really follow. England grasped the main facts of its existence protected by water and an industrial population needing large supplies of food from outside; hence an overwhelming navy, and behind the "sure shield" of the navy she knew she would have time, whatever arose, to plan, devise, and meet difficulties. In this great war she is doing that, as she ever did. All the appearance called unpractical, illogical, or muddling through, is but appearance. England is not unpractical. She is the most practical nation in the world. She is not formally logical, but she is idealistic, her ideal being that of freedom for her sons and for the whole world of nations, small and large alike.

After delivering the address, the Chairman presented the Society's medals which were awarded for papers read during last Session.

At the Ordinary Meetings:—

Sir William A. Tilden, D.Sc., F.R.S., F.C.S., "The Supply of Chemicals to Britain and her Dependencies."

William A. Young, "Domestic Metal Work of the Eighteenth Century."

J. A. Hunter, "The Textile Industries of Germany and of Great Britain."

Hon. John Collier, R.O.I., "Portrait Painting: the Technique of the Great Masters."

Professor W. J. Ashley, M.A., M.Com., Ph.D., "The Economic Position of Germany."

Horace M. Thornton, M.I.Mech.E., "The Industrial Uses of Coal Gas."

A. S. E. Ackermann, B.Sc., Assoc.M.Inst.C.E., "The Utilisation of Solar Energy."

Charles Darling, A.R.C.Sc.I., F.I.C., "Recent Progress in Pyrometry."

In the Indian Section:—

Captain Sir George Duff Dunbar, Bt., "Tribes of the Brahmaputra Valley."

Lieutenant-Colonel A. C. Yate, "The Indian Army."

Perceval Landon, "Basra and the Shatt-ul-Arab."

Sir Charles H. Armstrong, "Indian Trade and the War."

In the Colonial Section:—

Major E. H. M. Leggett, R.E., D.S.O., "The Economic Development of British East Africa and Uganda."

Edward R. Davson, "Sugar and the War."

For Special Lecture:—

Paul Lambotte, Directeur des Beaux Arts au Ministère des Sciences et des Arts de Belgique, "Constantin Meunier et les Sculpteurs Belges de son Temps."

Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., in proposing a hearty vote of thanks to the Chairman for his very able address, said it was not usual to discuss the subject-matter of the address at the opening meeting of the Session, but on the present occasion he was sorry that was not the custom, because many gentlemen were present at the meeting who could have added most useful commentaries to what the Chairman had said. To his mind the address had been a most clear and useful epitome of the material position in science, industry, and commerce, as between Germany and this country, and it ought to be most widely circulated. In particular, he would like every Member of Parliament to have a copy of it. Enough had been heard, at any rate, for the Fellows to congratulate themselves that so able a scientist as Dr. Dugald Clerk had kindly consented to be the Chairman of the Society for the present Session.

Mr. Charles Hawksley, M.Inst.C.E., in seconding the motion, said the Chairman's address had been most reassuring, and he hoped that not only the members but many others would take it to heart. He had clearly shown that England was not so much behind Germany as they had been apt to think, and he had proved that in many things she was actually ahead of her. He hoped that view would be widely spread, because there was a tendency not to give sufficient importance to what was done by scientists and other workers in this country.

The motion was put to the meeting by Sir Thomas Holdich and carried unanimously.

The Chairman having briefly acknowledged the compliment, the meeting terminated.

SUBMARINE OIL PIPELINES.

In the course of a paper on "The Petroleum Industry of Mexico," recently read before the Institution of Petroleum Technologists, Mr. P. Charteris A. Stewart gave an interesting account of the way in which large oil-tankers are loaded with oil while moored some distance out at sea.

Owing to the unfavourable nature and the comparatively shallow water close in to the coast, the Mexican Eagle Oil Company originated the idea

of laying submarine pipelines to points where the largest tankers could be conveniently moored for loading purposes at any state of the tide and weather.

They have three deep-sea loading berths at Tuxpam Bar, with duplicate pipelines to each berth; the Penn Mexican Fuel Company also have two loading berths equipped in the same manner with pipelines in duplicate.

The first two lines were laid by the Mexican Eagle Oil Company for the loading of the Oil Fields of Mexico Company's oil in March, 1910; these were six inches in diameter, and respectively 3,608 ft. and 5,150 ft. long below high-water mark. After being hauled through the breakers, these lines were continued into deep water by laying from barges, which was slow, costly and unsatisfactory work, as on reaching deep water the pipe developed bends in laying.

In view of the experience obtained with the first two six-inch sea lines, the succeeding eight-inch lines, each 5,150 ft. long, laid in 1911, were screwed up completely on shore on a carefully prepared wooden track twelve inches wide, at right angles to the shore, and directly in line with its permanent location. The pipe was mounted on small wooden trolleys, each running on a single roller; the trolleys were lashed to the pipe at alternate joints. The trolleys were removed during launching by cutting the lashings when they reached the end of the runway, allowing the trolleys to fall into a pit, from which they were removed as the hauling out progressed.

One hundred and thirty trolleys were used, each taking a weight of 1,277 lb., or two lengths of pipe. After screwing together, the end of the pipeline was closed by a bull plug, and the whole line coated with Texaco dip applied hot and spirally wrapped, like puttees, with burlap in strips twenty inches wide, after which another coat of Texaco dip was applied hot as before.

Uprights with vertical rollers were placed as guides at the water's edge on either side of the runway. An inch and a quarter steel cable, 1,750 ft. long, was made fast to the end of the pipeline, and taken out to a 3,000-ton steamer ("San Cristobal"), which was used as a tow-boat. In one instance this cable was taken out overnight, and, before hauling out commenced, got carried somewhere to the south and sanded over, so that the first pull was not in the true direction, and the necessity of the guide-posts was demonstrated; as a rule, however, after making the initial pull by means of her windlass on anchors previously laid ahead, the steamer had no difficulty in keeping on her course and towing out the line, at the rate of three to four miles per hour, to within a few feet of the buoyed position, the steamer towing the pipeline being attended by a tug to keep her bows in the correct course and correct any tendency to drift with the current, the slow speed of the towing not being sufficient to give the steamer steerage way.

The lines terminate in 43 ft. of water, which is below wave-action, and at the point where the iron pipe ends, 120 ft. of armoured flexible hose was attached by divers. The free end of the hose is closed by a blank flange, and allowed to lie on the sea-bottom when not in use, its position being marked by a small buoy attached to the hose by a chain sufficiently strong to lift it.

The rise and fall of tide is approximately two feet, so that the depth of water, 43 ft., is sufficient for the largest tank-steamers to load at any time; tankers of 15,000 tons dead weight drawing 28 ft. are regularly loaded.

Vessels loading come into position and moor to the permanent buoys, and are assisted, when required, by a tug of 1,000 horse-power permanently stationed at Tuxpam. After mooring, the tank-steamer picks up the marking buoy with the most conveniently situated of her own derricks, and raises the flexible hose alongside the vessel's rail. The hose is attached to the vessel's own loading connections, usually amidships, the weight of the hose remaining on the vessel's derricks.

The necessary control valves for the various lines are on shore, and are so arranged that any loading pump can be used on any line, or two pumps can be used to load one vessel. The loading station comprises three pump units, each of a capacity of 1,500 barrels per hour, or a total loading capacity of 4,500 barrels per hour, the pumps being suitably designed for handling heavy crude oils. They are triple-expansion, duplex, condensing, and can work up to a pump pressure of 450 lb. per square inch. Steam is supplied by the water-tube boilers, and the station is run continuously, allowing loading to proceed at all times.

With the code of signals in force between the pumping station and the vessel, it is possible to load the largest steamers in almost any weather, only fierce northers (75 kilometres per hour) occasionally interfering with loading operations.

As a rule it takes about twenty-four hours to load one of the large 15,000-ton tankers of the Mexican Eagle Oil Transport Company, which is equivalent to a loading rate of about 4,375 barrels per hour.

POTASH IN SPAIN.

For some time past potash deposits have been known to exist near Barcelona, and borings and analyses have been repeatedly made in the region where the salts are found in the provinces of Barcelona and Lerida. According to a report by the United States Consul-General at Barcelona, the results have been particularly favourable, but it will require the employment of capital and enterprise to make potash in this region a commercially profitable product.

In the various borings near the town of Sarria, potash salts were found at depths between 121·33 and 196·85 ft. and others at 426·50 ft. At 885·82 ft., the greatest depth attained, important quantities

of potassium compounds were found to rest on a stratum of white salt not yet pierced. In the area tested by borings comprising some 2,690,000 square ft. there are approximately 2,550,000 tons of carnallite and 1,150,000 tons of sylvite, which should produce a total of 3,675,000 tons of potassium salts.

From the general characteristics of the region it is considered probable that there are further deposits in greater or less proximity to those already tested. In a stream running by the salt works of Cardona there is a large percentage of potash in solution, and it has been discovered that vast quantities of potash have already been allowed to go to waste in the salt mines that might have been profitably used.

On account of the exceptionally irregular geological formation of this particular part of the country near Barcelona it is difficult to make exact valuations of the amount of potash salt that can be mined. Nevertheless, the presence of certain gypsum beds and the potash-holding streams will serve as a guide to determine the continuation of the potash deposits.

Particular interest has been displayed in these potash deposits by non-Spanish capitalists. One large tract is already owned outside of Spain, but in view of the great national importance of the deposits the Spanish Government are taking measures for their supervision, if not for their exploitation.

At the present time the amount of potash used per square mile of cultivated land in Spain is very small compared with that used in some countries. Nevertheless, fairly large imports of potash have been made in Spain, and it would be greatly to the advantage of Spanish agriculturists to use the domestic product, which it is calculated could be sold at about £10 a ton, or £5 a ton less than the cost of the imported product of the best grade. Since the beginning of the war, imports of potash have practically ceased. When the product now latent near Barcelona is brought to the surface and made a marketable commodity, there should ultimately be a surplus for export after the home requirements are satisfied. For the time being, however, in spite of a great outside demand, there can be no export of potash mined in the country.

GERMAN SUBSTITUTE FOR JUTE AND HEMP.

In view of the scarcity of jute and hemp in Germany for industrial purposes, German manufacturers have been directing their investigations along various lines in an effort to discover, if possible, some practical substitute for these fibres. That they have been successful in these endeavours would appear from a report of the recent meeting of the Union of German Jute Manufacturers, at which various samples of fibres from a German plant (*Epilobium hirsutum*) were submitted.

According to a report on the subject by the United States Consul at Breslau, this discovery was partly due to an accident. It appears that a man had used this plant as a roof-covering for a cart-house some years ago. Recently, in removing this old roof, he found that a certain rough hair-like fibre could be peeled off the stems or reeds. After a number of experiments with a quantity of these fibres it was further discovered that, on account of their age and the effects of the weather, they were too brittle for practical purposes; so several plants of this year's growth were tried, with the result, says the Consul, that another useful and practical textile fibre has been discovered.

Further investigations were made with other species of the *Epilobium* family, and it was found that all of them produced a fibre similar to hemp. The best results were obtained from the rough-haired willow rose (*Epilobium hirsutum*), followed by the narrow-leaved species (*Epilobium angustifolium*). All of these grow wild and in great abundance in Germany. The two species just mentioned have stems about 5 ft. in length, require no particular soil, and produce a fine fibre. It is believed that by attentive cultivation a fibre as valuable as jute may be obtained.

There are sufficient quantities of these plants in Germany to supply the jute manufacturers with fibres for a year, and the only question which confronts the manufacturers is that of gathering in the crop. For this purpose school children were to be employed during the holiday season, Government officials having promised to aid in the systematic organisation of these young harvesters. The Union of Manufacturers will give, it is stated, every encouragement to the further cultivation of this plant.

FLAX FIBRE IN THE UNITED STATES.

The common impression that flax fibre of a sufficiently good quality cannot be produced in the United States is declared to be quite unfounded in a new publication of the United States Department of Agriculture—Farmers' Bulletin, 669. "On the contrary," says the Bulletin, "it has been demonstrated beyond all doubt that fibre flax of excellent quality can be grown in various sections of the United States." Experiments, for instance, have shown that fibre flax from Puget Sound compares very favourably with that produced in the famous flax region of Courtrai (Belgium), and fibre of good quality has also been grown in Minnesota, Wisconsin, and Michigan. Weather records show that the temperature and humidity in the principal flax centres of Europe are much the same as those which prevail in certain sections of New York, Michigan, Wisconsin, Minnesota, Oregon, and Washington.

Nevertheless, there is a belief that the growing of fibre flax—a very different thing from the growing of flax seed—cannot be successfully carried on in America. As a matter of fact, at the present time it cannot be, but this is entirely because of

market conditions. The individual farmer can grow fibre flax, but he cannot prepare the fibre. Flax farmers, of course, could unite to pay for an experienced man to attend to this work for them, but under present conditions it would seem better for them to grow their flax under contract with the dealer. In the past, however, spinners and manufacturers have paid little more than half as much for American fibre as for the imported varieties of equal grade. In consequence, the fibre dealers cannot offer the farmer a high price for his product.

On the other hand, the production of flax fibre in Europe has been decreasing for some time, and at the moment the supply is practically cut off. It probably will be several years before the European production is as great as formerly, and it appears, therefore, that the present moment offers opportunities for the establishment of the industry in the United States.

During the past three years the prices paid to the farmer for flax straw with the seed, drawn directly from the shock, have varied from 10 to 17 dollars (£2 1*s*. to £3 10*s*.) per ton, and the yield has been about two tons of unthreshed straw per acre. The grower usually receives from 2 to 3 dollars (8*s*. 3*d*. to 12*s*. 4*d*.) more for pulled flax than for cut flax, and there is also a larger crop when the flax is pulled, thus saving all that would otherwise be wasted as stubble. Up to the present, however, no satisfactory pulling machine has been made, and, except where labour can be secured at a comparatively low rate, cutting the flax with a grain binder appears to be the more economical method in the United States. In Europe the usual method of harvesting is by hand-pulling. This not only increases the quantity of the crop, but prevents the fibre near the cut ends of the straw becoming discoloured or otherwise injured.

It is, however, after the straw has been harvested that the real difficulties begin. The preparation of fibre from the straw requires technical knowledge and skill, and can safely be undertaken only by those who are experienced in the work. For this reason the Bulletin referred to above urges prospective flax growers to make arrangements with dealers for marketing their product, or else by means of co-operative associations to secure the services of an expert.

PAINTING AND PREVENTION OF RUST.

The *Zentralblatt* draws attention to a series of experiments conducted by Liebreich and Spitzer to determine the effect of the number of coats of paint on the rate of rusting of iron. They polished four iron plates and painted them—the first with one coat, the second with two, the third with three, and the fourth with four. The plates were then exposed to steam for one day. The paint was dissolved off and the following distinct results noted:—

The iron under the single coat was bright all over, that under two coats was partly rusted, that under three coats rusted still more, while the iron under the four coats was covered with rust. This experiment shows that several coats of paint do not protect as well as one coat.

The explanation of this is that subsequent coats of paint or varnish tend to dissolve part of the previous coat. This has the effect of loosening the previous coat and making it porous, the porosity increasing with the number of coats. Air and moisture penetrate the pores and the iron below is rusted.

Where rust is feared, the coat of paint or varnish is usually made too thick, and the application of a second and third coat naturally does no good. The proper procedure is to remove all old paint by using the sand blast, solvents, etc., and then give the clean iron surface a single coat of the paint or varnish.

ARTS AND CRAFTS.

Women Home-Workers.—It seems to be inevitable that at this time of year the function of the artistic crafts which is most conspicuous should be the production of small objects suitable for presents. People do not refurnish or redecorate their houses as a rule in midwinter; they do not often put up stained glass windows at a time when, in our climate, there is little chance of seeing them in their full beauty. Big and important works of any kind are rarely exhibited in November and December, and the shops, with the exception of the jewellers and silversmiths and the booksellers, wait to show their more imposing wares until the days are beginning to lengthen. On the other hand, the approach of Christmas brings hope and opportunity to a host of home-workers in the artistic crafts, and to the growing class of semi-philanthropic organisations which provide work for the crippled, the mentally deficient, the blind, and those debarred for one reason or another from entering the labour market on quite the ordinary terms. One cannot help wondering what effect the war will have in the long run on undertakings of this kind; it would seem as though, in view of the increased taxation which we must expect, they might have to modify their working to some extent. It is, at any rate, to be hoped that they will be able to weather the difficult time which must lie before them. The case of the home worker is, perhaps, somewhat different. She (it is generally a woman) produces mainly luxuries which, though people in the past have been able to afford them, will not probably be much in demand in the years that are coming. Meanwhile, the shortage of men is giving many women their chance, and those who are not pre-eminently successful in their craft would, especially if they are young and unfettered, do well to consider whether they would not be well advised to turn their attention to some form of work in which they were helping to provide something that

people cannot do without. Many people (particularly women) appear not to grasp the fact that the spending power of the greater part of the well-to-do classes is going to be curtailed, not merely for the next few months or whatever limit they put to the continuance of the present struggle, but for some considerable time after, and that never again will conditions be just as they were before it began. That there will be room for a certain number of thoroughly well-equipped and competent women art workers who are also capable organisers, we all of us hope and believe, but it looks, to say the least of it, doubtful, whether in the domain of the artistic crafts there will be any place for women of lesser power, unless they are willing to take industrial posts, and to train as trade workers rather than as artists or artist-craftswomen.

Disabled Soldiers and the Artistic Crafts.—The exhibition and sale of Christmas toys and other objects made in the Lord Roberts' Memorial Workshops, which was held at Prince's Skating Club at the end of October, did not pose at all as an art exhibition. Its aim was to make known the work being done by our wounded soldiers, and to find a market for some of the work already executed. But the objects shown had for the most part some artistic interest. They consisted mainly of toys and baskets, together with furniture of a fairly simple type. The last was for the most part rather amateurish—it takes time to train even a sound man as a joiner and cabinet-maker—but the work was, on the whole, very promising. The baskets were of many kinds and their execution varied enormously. Some of them were really beautifully made, and the shapes were for the most part simple, sensible and good. There was very little of the fussy kind of product known as the fancy basket, and the majority of the exhibits would have unobtrusively held their own in the positions they were meant to occupy. The gilded baskets were rather garish, but with that exception there was very little fault to find with the work viewed as the output of men who were learning their trade and not past masters of it. The toys require rather more notice. Most people are determined that never again shall the overwhelming majority of our toys be imported from Germany, and there is a growing feeling that the toys of the future must be more beautiful than those of the past, better that is to say in colour and in form, and, in the case of more expensive toys, more individual. War economy is not likely to be allowed to take the form of depriving children of their toys, and it had been demonstrated long before this war that disabled soldiers and sailors could make wonderfully attractive wooden animals and the like, which rejoiced the heart not only of children but of parents, and bore evidence of having given pleasure as well to those who made them. Toymaking, therefore, suggests itself at once as an excellent trade for wounded soldiers, and the exhibition at Knightsbridge showed that those responsible for Lord Roberts' Workshops had realised the fact. Some of the most desirable toys, such as cannon, monitors and torpedo boats, did not leave very much scope for art, but the forts were a great improvement on the old imported ones, and the fairy stories, Cinderella, Jack the Giant Killer, Puss in Boots, and the rest, in which the lid of the box acted as a kind of drop scene and the principal characters were cut out and mounted on little wooden stands, so that they could be moved about at will and made more or less to act the story, were not only a happy thought but evidently conceived and controlled by someone with real artistic feeling. The toys as a whole, though not of course works of art exactly, were up to a standard of taste which was certainly not reached a couple of years ago. The prices were naturally a little higher, but they were by no means exorbitant. There were good toys to be had for a shilling and five shillings, though it was perhaps rather more difficult to find what one wanted at the popular price of half-a-crown. The exhibition, however, was a very good one, and augurs well for the success of the workshops.

Embroidery at Westminster.—The Needlework Competition of the *Daily Sketch* attracted an extraordinary number of competitors, and the exhibition held at the Central Hall, Westminster, included plenty of really good embroidery, some of it employed to excellent artistic purpose. There were over thirty classes, most of which were to do with lace and embroidery. For all that the show was, to the lover of art needlework, somewhat of a disappointment. In the first place, as the objects were mostly for sale, they had to be displayed in a fashion which made it rather difficult to study them. Further, the lighting of the Central Hall is not peculiarly well adapted to the exhibition of fine needlework, and it was almost impossible to judge of the stitchery of a good deal of the work. The visitor to the exhibition was, moreover, rather oppressed with the feeling that at the present moment there was no very insistent demand for important and expensive pieces of embroidery, and that the amount of energy which had been put into the production of the objects on view could just now have been employed to greater advantage. At the same time the work, especially in some of the classes, reached at times a high level of artistic and technical achievement, and it was both interesting and instructive to see so large a collection of artistic needlework of all kinds. The Church embroidery was a little disappointing, for while some of the smaller objects were tasteful and well executed, much of the larger work was mechanical in the extreme. There was a good show of tapestry and *petit point*, some good cutwork, and a great deal of satisfactory old English embroidery, but perhaps the most interesting section was that devoted to needlework pictures. The panel which took the first prize in this class was a beautiful piece of work, admirable both in treatment and in

stitching; but a considerable number of the competitors who sent in figure pictures had fallen into the error of attempting a type of pictorial representation quite beyond the powers of the needle. The landscapes were happier, and many of them were really attractive pictures in stitchery which had, one felt, been drawn with the needle, and showed no striving on the part of the worker to attempt the impossible.

Women's Work at Knightsbridge.—The Exhibition of Women's Work now being held at the Prince's Skating Club is an interesting show, but hardly perhaps justifies its sub-title of "an Exhibition of the Arts and Crafts of the Homeworker," for it includes very little of the work of the best women craftworkers. Its value on the arts and crafts side is mainly due to the fact that a number of guilds, societies, and associations are exhibiting. Amongst these may be noted Queen Alexandra's schools of needlework and of woodcarving at Sandringham, from which come exhibits covering a very wide field; the Dun Emer Guild, which makes a speciality of Celtic designs; the Barclay workshops for the blind, which show some admirable weaving, some of it in patterns; the Hampshire House workshop, whose exhibit of dressmaking and embroidery attracts by the brightness and freshness of its colour; and the Essex Handicraft Association, which sends, amongst other things, some good run lace. The war cannot be making it easy for undertakings of this kind to continue to extend their work, and it is satisfactory to see that they are doing their best to carry on, and in some cases adapting themselves to changed conditions.

OBITUARY.

Sir Patrick Playfair, C.I.E.—Sir Patrick Playfair died at his residence in Ennismore Gardens on the 12th inst.

The son of Mr. Patrick Playfair, of Dalmarnock, Lanarkshire, and Ardmillan, Ayrshire, he was born in 1852, and after being educated at Loretto and Glasgow University, he went out to Calcutta, and eventually became a partner in the mercantile and jute manufacturing firm of Messrs. Barry & Co. He was Vice-President and subsequently President of the Bengal Chamber of Commerce, which he represented on the Bengal Legislature. From 1893 to 1897 he served as additional member of the Legislative Council of the Viceroy and Governor-General of India, and he took an important part in the establishment of a separate Department of Commerce and Industry, with a member of the Viceroy's Executive at its head. He was sheriff of Calcutta in 1896, and was created a knight in the following year. He was also one of the organisers of the Victoria Memorial in Calcutta.

In 1899 he organised the first body of British Volunteers from India to fight beyond its shores, and it was largely due to the assistance rendered by him to his old friend, the late Colonel D. M. Lumsden, C.B., that Lumsden's Horse was raised.

Sir Patrick became a member of the Royal Society of Arts in 1898. He served on the Indian Section Committee from 1900 to the time of his death. He frequently attended meetings of the Indian Section, and occasionally took part in the discussions.

NOTES ON BOOKS.

Savage Man in Central Africa. By Adolphe Louis Cureau. Translated by E. Andrews. London: T. Fisher Unwin. 12*s*. 6*d*. net.

This is a book of remarkable scientific interest. The author lived for over twenty years in the French Congo, and during that time he devoted himself to a minute and careful study of the natives in that great region. For this task he had very special qualifications: he spoke their dialects, he lived their life, and, being endowed with a sympathetic and understanding nature, he thought their thoughts as far as is possible for a mind so unlike their own. The result is a wonderfully comprehensive and clear account of the Central African as he exists to-day, based entirely upon M. Cureau's first-hand observation.

The plan of the book is divided into three parts—the first describes the geographical and human environment of the French Congo; the second deals with the psychological individual as an element of social life; and the third with the social life itself. The French Congo covers an immense extent of ground, and the author had opportunities of studying the life of the native in all stages of its complexity, from the simple couple to the highest social organisations to be found in tropical Africa.

Some of the author's conclusions, as one might perhaps expect of one whose observations have been so careful and so extensive, are of the nature of heresies. For instance, he has no exaggerated opinion of the fineness of the black man's senses. "The negro," he says, "neither sees nor hears better than we do, even in the bush. He is simply more accustomed to the sights and sounds of his native land. It is the education of his senses, not their keenness, which enables him to distinguish game among the thick foliage or to recognise the distant summons of the war-drum. In this respect we are no whit inferior to him; indeed, we assert our superiority as soon as we have adapted our eyes and ears to the conditions of the African environment."

In this connection M. Cureau has some remarks on the value of psychological experiments, which may be commended to the attention of some of our present-day experimental psychologists. "Experimentation" [*i.e.*, in the case of the Negro], he remarks, "seems to me quite impracticable, if one wishes to obtain certainty and accuracy. Most of its processes demand that the

patient shall yield himself to them intelligently, and shall realise what is expected of him. You need hope for nothing of the kind from the Negro. I have often noticed how the clinical examination of sick natives is hindered by impediments due to the patients themselves. When one attempts to make them breathe, count, cough, assume certain positions, their awkwardness is so great that it reduces medical observation to purely objective indications, as in the case of children and animals. Hence we must be satisfied with the superficial observation sufficient for our present object."

M. Cureau has made a point of avoiding anecdotes which are merely picturesque. He does, however, tell one or two, which throw light on the Negro's psychology. Of these, perhaps, the most illuminating is a tale he relates to illustrate the fickleness of the native character: "The captain of a French steamer, who had put in at a village to buy provisions and wood, recognised, in a crowd which came running down to the river bank, a man who was a stranger to that district, and who had lately served as steersman on his boat. When questioned as to what he was doing there, the man replied that he was a captive in the village, and as such was destined some day or other to fill the cooking-pot of his masters. The captain thereupon offered to carry him off. He refused, because at the time he was enjoying all the luxuries of life, and the prospect of the knife had consequently no power to disturb him. The boat left without him."

Thanks to the author's easy style and the excellent translation which Mr. Andrews has provided, the book is extremely readable. At the same time it contains an immense amount of information, the fruit of twenty years' careful observation and study, and is a most valuable addition to anthropological literature.

Oil Seeds and Feeding Cakes. With a Preface by Wyndham R. Dunstan, C.M.G., LL.D., F.R.S. London: John Murray. 2*s*. 6*d*. net.

This volume contains the first series of monographs published by the Imperial Institute. The subjects dealt with are copra, palm kernels, ground-nuts, sesame seed, and mowra seed. Of these substances the first two have recently been brought prominently to the notice of stock owners as a result of the war. Formerly large quantities were exported to Germany and Austria-Hungary, but the closing of these markets has made it necessary for growers to find a new outlet for their products. In the case of copra, while a certain amount formerly came to Great Britain and France, the annual export to Germany and Austria was about 150,000 tons, valued at some £3,250,000. The situation was brought by the Imperial Institute to the notice of the principal British firms interested in copra, or likely to be so, with the result that the exports to London from Ceylon have risen from 1,500 cwt. in 1912 to 562,500 cwt. in 1914.

The story of the palm-kernel industry is very similar. Before the war Hamburg was the port to which practically all palm kernels were shipped, and the crushing or pressing operation was carried out there. The trade was a very large one, and a great proportion of the raw materials came from British tropical possessions—*e.g.*, in 1912 Germany received from British West Africa alone 250,000 tons of palm kernels, valued at £3,800,000. When the war broke out there was practically no market in this country for palm kernels, but a considerable industry has now sprung up, and, so far as British West Africa is concerned, the regular export of kernels to Great Britain has now been established. Both copra cake and palm-kernel cake are excellent food for cattle, the latter being particularly suited to milch cows, and the Board of Agriculture have published a special leaflet (included in this volume) in which the merits of both foods are described and analysed.

The great market for ground-nuts was Marseilles, where a very large industry was carried on in expressing oil and manufacturing cake. The latter was mainly exported to Germany, where its merits as a cattle food were well recognised; but since the closing of this market the Marseilles industry has fallen off, and there is now a great supply of ground-nuts to be disposed of. In addition to supplying a good cattle food, the ground-nut yields an oil which is useful in the manufacture of margarine, etc. It also has a further valuable property: it is a leguminous plant and possesses the power of fixing the nitrogen of the air, and rendering it available in the soil as a plant food, so that in the rotation of crops in the tropics, and especially in connection with cotton cultivation, the growth of the ground-nut is of great importance.

The principal use of sesame and mowra seeds is to provide edible oils. The first yields a well-known substitute for olive oil, and is most used in the manufacture of margarine; the second furnishes a fat much used for cooking by the natives of India.

There seems to be no doubt that the industries in connection with all these substances are capable of very great expansion, and the publication of this volume ought to do a great deal to establish them firmly in Great Britain.

English Railways: their Development and their Relation to the State. By Edward Cleveland-Stevens. London: George Routledge and Sons, Ltd. 6*s*. net.

The object of this book (which forms No. 42 in the series of monographs by writers connected with the London School of Economics and Political Science) is to present a detailed historical account of the consolidation of English railways up to the year 1900. Considering the enormous importance of our railway systems, and the vast interests which they represent, the amount of general literature on the subject is surprisingly small, although official records (*e.g.*, Parliamentary Papers, Hansard's Debates, Reports of Inquiries, etc.) and periodical literature (*e.g.*, railway newspapers and pamphlets)

are voluminous. The student of railway history will, therefore, be indebted to Mr. Cleveland-Stevens, who has produced from this heterogeneous mass of material a well-digested and methodical account of the evolution of English railways. Some idea of the labour involved in tracing out this development may be obtained from the statement that our present systems are "the consolidated outcome of more than a thousand separate companies of earlier days." The same idea is also graphically conveyed by two maps, showing the railway systems of 1848 and those of the present day, in which a short mileage under many companies is contrasted with a long mileage under the control of few.

Throughout the book Mr. Cleveland-Stevens plays the part of the impartial historian. He regards a knowledge of the past history of railways as a necessary preliminary to the intelligent study of the problem of their control in the future. The lines on which that problem is to be solved do not, of course, come within the scope of the present volume; but from the accounts given of the suicidal competition and inadequate services of small companies, it is not very difficult to guess something of the direction in which, in the author's opinion, they ought to develop.

GENERAL NOTES.

Water-power Development in Relation to Fisheries.—The construction of the great dam for hydro-electric power development in the Mississippi River at Keokuk, Iowa, has created, incidentally, the opportunity to study certain factors of importance to the conservation of river fisheries. The subject of fishways, which has attracted considerable attention from the engineering aspect, has never been studied adequately by biologists under actual field conditions. It is now officially announced, by the United States Bureau of Fisheries, that the bureau is conducting observations to supply the deficiency of information. The existence of a practical barrier in the river at Keokuk also affords unusual facilities for the study of fish migrations, and the creation of a large river lake above the dam probably will make feasible the development of important fisheries similar to those now conducted in Lake Pepin, a natural lake of generally similar configuration. As the conditions in the lake gradually assume permanency the loss of crops on the drowned farm lands should be compensated for in considerable measure by an increasing fish supply.

Production of Tanning Extract and Alcohol from Sulphite Lye.—The Norwegian *Farmand* states that an establishment for utilising the waste lye from sulphite pulp production is now being built at Embretsfos, near Drammen. The establishment will be ready to begin work in three months, and it is estimated that the production of tanning extract from the lye will be about 3,000 barrels per year. Also a factory for producing alcohol from the lye will probably be built in the near future in connection with a Norwegian cellulose mill.

The National Wealth of the United States.—The United States Bureau of the Census has just issued a bulletin, entitled "Estimated Valuation of National Wealth, 1850–1912," in which are given estimated values of the various classes of real, personal, and other property owned in each State and in the district of Colombia in the year 1912, with comparative figures for 1904 and earlier years as far back as 1850. The aggregate for the United States in 1912 was $187,739,000,000, which is equivalent to $1,965 per head. This bulletin has been prepared in connection with the Bureau's decennial investigation of wealth, debt, and taxation, and the statistics contained in it will later form a part of the final report upon that subject. These estimates are not presented as very close approximations to accuracy, but as being the best which can be made from the data available, and as being fairly comparable with those published eight years ago, relating to 1904. Copies of the bulletin can be obtained on application to the Director of the Census, Washington, D.C.

Formosa Sugar.—The latest official returns of the sugar-mills in operation in Formosa give the total of modern-style mills as 36, with a crushing capacity of 27,070 tons per day. There are also 39 old mills with a crushing capacity of 3,190 tons per day, besides 220 old native mills of unknown but small capacity. The area of fields under sugar-cane during 1914 was 215,198 acres, producing on an average (estimated) 14½ cwt. of sugar per acre. Early in 1915 shipments of refined sugar were made to Hong-Kong, which, however, were probably intended for re-export elsewhere. While the war doubtless gave an impetus to this export, it is only the realisation of hopes long existing, and efforts will not be spared to maintain a position in foreign markets.

Population of the Russian Empire.—The total population of the Russian Empire at the present time is estimated at 170,350,000, sparsely distributed over an area of 22,012,000 square kilometres (8,226,632 square miles). Of this, Russia in Europe, with a population of 137 millions, covers an area of 5,390,000 square kilometres (2,080,540 square miles), and Asiatic Russia, with a population of only 33,350,000, occupies 16,622,000 square kilometres (6,146,092 square miles). The number of inhabitants of the principal cities in order of their importance is: Petrograd, 1,911,000; Moscow, 1,505,000; Warsaw (before German occupation), 864,000; Odessa, 498,000; Kiev, 447,000; Lodz, 404,000; Riga, 328,000.

Germany's Food Supply.—Professor W. J. Ashley has followed up the admirable paper on "The Economic Position of Germany," which he read before the Society last February, with an article in the current number of the *Quarterly Review*. It is entitled "Germany's Food Supply," and in it the author deals with the food question at greater length than was possible in his paper, and with reference to later developments in the matter. A great many new facts are discussed, and the whole article deserves the close attention of all interested in the economic aspects of the war.

French and Flemish Books for Belgian Wounded.—The Comité des Visites aux Blessés Belges appeal for French and Flemish books in order to give to the Belgian wounded soldiers literature in their own language. About 3,000 volumes have already been received. These have been widely circulated, and it would be difficult to exaggerate the pleasure which they have given. But amongst the wounded are many students and technical workmen, who desire to follow up their studies, and for this purpose want books on science and engineering, chemistry, physical science, mathematics, mechanics, electricity and other sciences, and also commercial study books, technological works, etc. The Committee appeal earnestly for gifts of this kind, or for financial help which would allow them to buy such books. All parcels and letters should be addressed to Madame Carton de Wiarts at the Library Department of the Committee, Sardinia House, Sardinia Street, Kingsway.

The Professional Classes War Relief Council.—A great sale, which is being organised under the patronage of their Majesties the Queen and Queen Alexandra, will be held at the Royal Albert Hall on December 8th, 9th, and 10th. The Fine Art section will be devoted to pictures, curios and antiques of all kinds, and special appeal is made to those who have such objects in their possession, as it is felt that there are many who would be willing to give active and generous support by making donations to this section who would perhaps find it impossible to make the usual contribution. Gifts of every kind will be very gratefully received and acknowledged by the Gifts Secretary, Royal Albert Hall, London, who will be happy to answer any inquiries as to donations. A fund has already been raised to cover all expenses connected with the sale, and therefore the entire proceeds of the sale will go direct to the funds of the Professional Classes War Relief Council.

MEETINGS FOR THE ENSUING WEEK.

Monday, November 22...Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. C. H. Hewitt, "Handwork on Negatives, including Knife-work."

Surveyors' Institution, 12, Great George-street, S.W., 8 p.m. Mr. E. M. Konstam, "Case Law under the Finance Acts."

Tuesday, November 23...Illuminating Engineering Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Discussion on the First Report of the Departmental Committee on Lighting in Factories and Workshops.

Sanitary Institute, 90, Buckingham Palace-road, S.W., 4.15 p.m. Dr. L. Parkes, "The National and Social Aspect of the Lower Birth-rate."

Royal Dublin Society, Leinster House, Dublin, 8 p.m. 1. Professor W. Brown, "The Subsidence of Torsional Oscillations and the Fatigue of Iron Wires when subjected to the Influence of Alternating Magnetic Fields of Frequencies up to 250 per second." 2. Mr. P. E. Belas and Dr. M. Hartog, "On the Path of a small Permeable Body moving with negligible acceleration in a Bi-polar Field." 3. Mr. T. G. Mason, "Preliminary Note on the Carbohydrates of the Musci." 4. Mr. J. J. Dowling, "A New Form of very high Resistance for use with Electrometers."

Photographic Society, 35, Russell-square, W.C., 8 p.m. Mr. H. Main, "Nature Notes near Home."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Mr. G. A. Boulenger, (*a*) "A list of the snakes of East Africa, north of the Zambesi and south of the Soudan and Somaliland, and of Nyassaland"; (*b*) "A list of the snakes of North-East Africa, from the Tropic to the Soudan and Somaliland, including Socotra"; (*c*) "Descriptions of a new Amphisbæna and a new snake discovered by Dr. H. G. F. Spurrell in Southern Colombia." 2. Professor A. Dendy, "On some Land-Planarians collected in Western Australia and Tasmania by members of the British Association for the Advancement of Science." 3. Mr. C. T. Regan, "The Morphology of the Cyprinodont Fishes of the Subfamily Phallostethinæ."

Wednesday, November 24...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. Sir Edwin Pears, "Constantinople, Ancient and Modern."

Electrical Engineers, Institution of (Local Section), The University, Birmingham, 7 p.m. Professor A. B. Field, "Some Difficulties of Design of High-speed Generators."

Japan Society, 20, Hanover-square, W., 8.30 p.m. (Joint meeting with the China Society.) Mr. L. Binyon, "The Art of Asia."

Thursday, November 25 ... Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. J. H. Knight, "The Early History of Railways."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Professor A. B. Field, "Some Difficulties of Design of High-speed Generators."

Optical Society, Burlington House, W., 8 p.m. Mr. J. H. Sutcliffe, "The Influence of Visual Errors in Musketry."

Friday, November 26...Engineers and Shipbuilders, North-East Coast Institution of, Newcastle-on-Tyne, 7.30 p.m.

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Saturday, November 27...Municipal Engineers, Institution of, 4, Southampton-row, W.C., 12 noon. Annual General Meeting. 2.30 p.m. 1. Presidential Address. 2. Mr. H. Boot, "The Manufacture of Cement." 3. Mr. W. L. Carr, "The Benefits derived by an Urban District adopting a Town-Planning Scheme."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, NOVEMBER 29th, at 4.30 p.m. (Cantor Lecture.) WALTER ROSENHAIN, D.Sc., F.R.S., Superintendent, Metallurgy Department, National Physical Laboratory, "Optical Glass." (Lecture I.)

TUESDAY, NOVEMBER 30th, at 4.30 p.m. (Colonial Section.) SIR SYDNEY OLIVIER, K.C.M.G., late Governor of Jamaica, "Recent Developments in Jamaica: Internal and External." SIR HENRY A. BLAKE, G.C.M.G., will preside.

WEDNESDAY, DECEMBER 1st, at 4.30 p.m. (Ordinary Meeting.) THE MASTER OF CHRIST'S COLLEGE, CAMBRIDGE (Arthur Everett Shipley, Sc.D., F.R.S.), "Insects and War." SIR WILLIAM J. COLLINS, K.C.V.O., M.S., F.R.C.S., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

JUVENILE LECTURES.

Two of the Members of the Council—Professor John Millar Thomson, LL.D., F.R.S., and Mr. James Swinburne, F.R.S. — have kindly undertaken to deliver the Juvenile Lectures this year. Professor Thomson will give the first lecture on Wednesday afternoon, January 5th, at 3 p.m., his subject being "Crystallisation." Mr. James Swinburne will give the second on Wednesday, January 12th, at 3 p.m.; his subject will be "Science of some Toys." Both lectures will be very fully illustrated with experiments.

Special tickets are required for these lectures. They can be obtained, when ready, on application to the Secretary.

A sufficient number of tickets to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to a ticket admitting two children and one adult. Fellows who desire tickets are requested to apply for them at once.

PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

Wednesday, November 24th, 1915; COLONEL SIR THOMAS HUNGERFORD HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., Vice-President of the Society, in the chair.

The following candidate was proposed for election as a Fellow of the Society:—

Thain, James Edward Vyner, C.S.P. College, Exmouth, Devon.

THE CHAIRMAN, in introducing Sir Edwin Pears, said that he was really introducing the one man in all England who was best qualified to speak on the subject of Constantinople. His long residence there, and his practice as a lawyer, which brought him into contact with every class of society, his immense powers of observation, and, more than all, his literary ability, which had resulted in a most excellent history of the place, all seemed to bear out that view.

The paper read was—

CONSTANTINOPLE, ANCIENT AND MODERN.

By SIR EDWIN PEARS.

When I was asked to read a paper, or speak, on the subject of "Constantinople, Ancient and Modern," I had to consider what view I should take of the matter. Naturally, in an audience like this, there are people who do not know much about the subject, and there are undoubtedly experts, equal to any to be found in England; and, therefore, it seemed to me to

follow that what I had to say should be of a popular character as far as possible, but not losing sight of the great points which are of especial interest to us at the present moment.

Let us begin with Ancient Constantinople. I suppose everybody in the room knows that Constantinople was founded by the Great Emperor Constantine, and that on the official Name Day, 330, it received the name of New Rome. The Patriarch, as you are aware, signs himself to this day *Patriarchus novæ Romæ*, and has done so from that time to the present.

Now I am not going to attempt to give you any kind of history of the place throughout those years. I will take some of the brief periods during which Constantinople has written its name largely on the pages of time. We will pass Constantine altogether and go on to two centuries later, when we get to the period of, I think on the whole, the greatest Emperor that ever ruled in Constantinople—Justinian. I daresay that many of you—many of the ladies even—have read a good deal about him, especially his personal side. You all know his love for the beautiful actress Theodora, his constancy to her, his insisting on marrying her, and how she proved a very good wife. I think everybody admires that famous scene when, in the great riots that took place in the city between the liberals and conservatives, otherwise called the blues and greens, the whole city was in an uproar, and the two factions united with each other in order to get rid of Justinian. Then poor Justinian lost his head, as we men occasionally do. But the wife kept hers, and the speech she delivered on the occasion is one that comes rolling down the centuries with a fine message. "I have worn the Imperial purple. If we are to be captured and killed, well, the Empire's purple is a glorious winding-sheet. Let us fight it out!" And with the aid of the great generals, Belisarius and Arsenius, they fought it out, and Justinian was able to continue the work of his lifetime—and a wonderful work it was.

In the first instance Justinian is spoken of as a great lawyer, and he is responsible for what we Latins call Roman Law, meaning by that the law of the New Rome and not of the city on the Tiber. Those of you who are not lawyers can hardly imagine what an enormous effect the law of Justinian has had upon the jurisprudence of the world. There is not a civilised country in the world at this moment whose law is not saturated with the principles laid down in the time of Justinian.

Our own English law and, to a certain limited extent, that of Russia are the two which owe least to the legislation of Justinian, but if you ask any equity lawyer he will tell you that the principles on which our Courts of Equity act are all taken bodily from the Law of Justinian. Then, if he knows what he is talking about, he will tell you that the laws of France, of Italy, of Spain, of Belgium, and of a large part of Germany are simply the Codes of Justinian with slight modifications. So that this Emperor —and we must attribute the advantages of the change to the Emperor himself—gave law to the civilised world. Now, in addition to that, Justinian is spoken of as the great road and bridge builder, and perhaps for my present purpose that is his most convenient designation. Justinian the road maker and bridge builder is, I will not say more renowned, but equally renowned with Justinian the law-giver. Now what did he do in the way of road making and bridge building, and why did he do it? For the purpose of answering those questions I must ask you to listen to a matter as to which, on the only occasion when I have spoken on this subject since I was in London, I received several letters, the latest being received only yesterday. The history of the trade and commerce between the East and the West is always a fascinating subject and is one that in the course of the long existence of this Royal Society of Arts has, I am quite sure, often attracted the attention of the members. It used to be said with a certain amount of truth—certainly it was true until the year 1700 —that the nation which possessed the trade between the East and the West was necessarily the richest nation in the world. If you go back to really ancient history, say one thousand years before Christ, you will find that at that time Egypt, so far as the West was concerned, had a monopoly of the trade between the East and the West, the East standing for India and the countries beyond. The trade from Egypt to the East went at that time along three well-known roads: the first led from Egypt through Petra—which you all know by the beautiful photographs that have been taken during the last two or three years by the Society called the Palestine Exploration Fund. The ruins of Petra are extremely beautiful, and show that the city was at one time well supplied with water and was a really beautiful city. From there the road struck almost due east right across the Arabian Desert to the Persian Gulf. That was the first and the earliest great

road that we have between the East and the West. At the present time the road is absolutely impossible because there is no water in any part of it.

Then let us jump our periods of history to about a thousand years before the time of Christ—that would be the time of Solomon. The wise king of the Jews had the sense and the capacity and the ingenuity to divert the stream of traffic between the East and the West so that it should pass through his kingdom of Judea and so make him and his people rich. When that diminished, a second passage was established: it already existed in the time of Solomon, and was in full use at the time of Christ. That passed from Egypt along the Mediterranean coast in the country of the Philistines, Philistia as it is called, then took the valley through Judea —and if you had some of the beautiful relief maps of the Palestine Exploration Fund you would see the great natural depression that exists—and then struck due eastward, practically following the same road as was followed by the first road that I mentioned, which was already nearly out of use in the time of Christ. There was a third road which at that time was in full vigour, and came into still greater vigour during the next two centuries, which ran through Palmyra, or, as it is called in the Bible, "Tadmor in the Wilderness." I have not been to Tadmor, for when I was at Damascus, which is the nearest place to it, they said to me, "If you go you will die for a certainty," and I had not the slightest intention of dying at that time. It was a very hot season. The only water that exists in Palmyra is derived from a number of marshes in the neighbourhood which support a few wandering Bedouins. It is a deserted city. It was so entirely deserted that it was forgotten, and any of you who care to turn up in Bohn's Library the volume on "Early Travels in Palestine," will see there an account given by our chaplain at Aleppo, who took a party of colonists there. They went to explore these ruins—and superb ruins they are, though I only know them by photographs—and they then found that this mass of ruins was Palmyra. You may recall the fact that the famous Arab Queen, Zenobia, held court at Palmyra until she was defeated by the Romans.

These were the three great ancient roads that crossed the country and along which trade passed. There had already commenced in that part of the world a long period of drought; Arabia and Syria have for centuries—for millenniums, indeed—been liable to periods of alternate moisture and drought. You have got some proofs of that in the Old Testament. You remember the story of Jacob and Joseph, and of there being no pasture for the flocks, and of the people going down into Egypt to obtain provender for themselves and their flocks. That is an experience that has in the course of centuries been constantly repeated. After the time of Zenobia the districts to the south gradually became drier and drier. I could give you scores of illustrations as to how they became dry and as showing that they had dried up. For example, you all know that the Dead Sea is 1,300 feet below the level of the Mediterranean. It is below the level of the Mediterranean at the present time, but the old sea beaches that are around the Dead Sea show that at various times it has been very much higher. For example, Nazareth, which is now well up on the hills, was on the borders of the lake, and if you go farther north you come to the lake on which Capernaum and Gennesareth stood, which, in the time of Christ, were villages on the shores of the lake, but are now ruins on the hills. The water has receded. An old Russian monk, who visited the country about the year 1100, has a very poetical story that when Christ went down to the Jordan the waters fell back before their Lord and Master: that is his explanation of the water receding. However, we have nothing to do with poetry here, but plain matter-of-fact. The drying up of the country had enormously diminished the trade between East and West. Justinian saw that it might be recovered if roads existed between the Bosphorus, where he was reigning, and the Persian Gulf. Accordingly his first task was to make roads. We know where most of the roads were; some of them can be found very well in traces at the present time; along them there are the sites of cities that have long since been deserted, sometimes because the period of drought continued, sometimes on account of sheer pure misgovernment. I see in the audience two of my friends who know Smyrna better than I do, and from Smyrna there is a very charming expedition that may be made to Hierapolis. Now what is Hierapolis? In the first instance it was distinctly on one of these great Justinian roads. What is it now? What was it then? If you want to see what it was then, you can read a very fine account in Renan's Travels, and another, perhaps more practical, in those of my friend Sir William

Ramsay. In the first place, its position is superb. I know the Tyrol fairly well and Switzerland, but I know no valley that is more beautiful than that which the Smyrniotes call the Asiatic Switzerland. Amidst the great amphitheatre of hills there flow springs of hot water. I fancy the temperature is usually about 170° or 180° F. These well up from the ground and flow along the streets of an ancient city, and, depositing a certain amount of lime, have built themselves channels by the side of the street, where the water has been running for the last three thousand years, possibly longer. You can see the ruins of two enormous theatres, one of which we calculated would seat 30,000 people and the other 20,000. You see the ruins of churches and temples and especially of a large bathing establishment. The place had been knocked about considerably by earthquakes, but still you can see every indication that the city was once a wealthy city and well inhabited. What is it now? Who live in it now? A few gipsies, as useful and as useless as gipsies usually are. I speak of them as gipsies because they belong to the great families of Nomads. There is not a soul except these wandering Nomads who lives in the place. The waters are running as quietly and beautifully and making as beautiful terraces as they have ever done, but the place is a mass of ruins. That is one set of ruins on one of Justinian's roads, and one can hardly pass from that part of the world without remembering what Ephesus was. The best account that I have ever seen of Ephesus was written by Dean Farrar in his book on the Epistles of the Apostle Paul. He made a careful study of what the city was, and pictures a highly-cultivated and highly-civilised place, with half a million inhabitants. It is very wonderful and very interesting now to sit in the ruins of the very theatre that you read about in the Acts of the Apostles, where the great riot took place, the makers of the images of Diana fearing that their trade was going to be damaged by these new men who were preaching about a new God in the city. That, however, is apart from my purpose here to-day. This great city is now dried up. The quays, the wharves, are still there, and the iron rings along the wharves are not yet entirely rusted away. But it is naturally a scene of desolation.

We arrive at the point that Justinian, the great road maker, succeeded by this great measure of his in attracting the commerce of the eastern world of India and China and the districts outside what is now the region of Turkey, to the Bosphorus, and thereupon the commerce of Constantinople increased enormously and the city became wealthy.

Justinian is spoken of also as the bridge maker, and in the way of bridge making it would be easy to give you many striking examples of what remains. The only one I will mention now is one that I know very well at a place called Sabanja. I had read of the bridge there and wished to see it. It is a bridge which I suppose, is just about twice the length of Waterloo Bridge, and I compare it with Waterloo because, like that bridge, it has no pitch in the middle, but is entirely on a dead level. One day when it was raining very heavily and my friends were out shooting, I went exploring for this bridge. When I reached it, the first and most striking feature was that there was no water. The bridge is built over a marsh. At the end of this splendidly constructed bridge, which has lasted from about 570 down to the present time, is a *tête de pont*, under which five hundred soldiers might have sheltered themselves, who were there, of course, to guard the bridge in case of any invasion along this great road. The authorities say that in the middle of the bridge, and by the side of it, there was an inscription which ran something like the following—I did not see it because I was wet through, and I had to make certain sketches and then get back to the village about eight or ten miles away: "Thou, old river, which hast hitherto flowed by thine own will, hast been compelled for all time by the divine Justinian to flow under this bridge." As a matter of fact, the river has broken away, and there is no stream nearer than ten miles—one of Nature's practical jokes.

I have described Justinian to you as a road builder, a bridge builder, a law-giver, and a man who introduced prosperity into Constantinople. From his period to about the year 1000, with intervals, of course, there was in Constantinople a period of prosperity. We might well ask ourselves, "What was the condition of our country at that time?" Try if you can to picture what our ancestors were like in 550 and 650 and 750 A.D. We were just beginning the emigration into this country from the marshes of the Elbe and of the rivers that flow into the Black Sea. We will not say that we were highly civilised, and we will not say that we were savages at that time, but the most civilised country on the face of the earth was the country ruled from Constantinople. During

the time while our ancestors were peopling these islands and were civilising themselves, the citadel of Europe was being kept at Constantinople. There were great periods when rushes took place of masses of men, due to these periodical droughts that I have spoken of, the object of which was to get across the Bosphorus and gradually to overwhelm this part of the world as they have overwhelmed others. A period of quite exceptional drought commenced early in the sixth century and continued for upwards of a century, gradually getting worse and worse. What is the effect of drought in Arabia? The Arab shepherds attending to their flocks want pasture; if they do not get pasture they cannot live. During that time, as you all remember, Mahomet appeared as the great prophet of Arabia. One of the questions which interested me twenty-five years ago when I commenced my study of the history of Constantinople was: Where, in the name of goodness, did the enormous armies that the followers of Mahomet gathered together come from? Arabia could not furnish armies of half that number at the present time. Where did they come from? What is the explanation?

The explanation did not dawn upon me till some eight or ten years ago, when, in consequence of the explorations made in Central Asia by the United States Exploring Expedition, we who take an interest in these matters learned the fact that there were periodical droughts and times of moisture, and the time of great drought commenced in the seventh century and drove the people, the Arabs, forward to follow the followers of Mahomet wherever they could get a living. You know what wonderful progress they made. I think it is the most wonderful progress of which history bears record. They start from Mecca, they conquer the whole of Arabia and Syria and Egypt, every single country along the north shore of Africa, that is to say, on the south border of the Mediterranean, right away until you get to the Atlantic. They cross the Atlantic at the Straits of Gibraltar; they sweep over Spain and conquer every corner except that brave north-west corner which held out for 400 years against the Moslems, and then they storm over into France and, as Gibbon in his delightful, cynical manner, observed, it then looked as if succeeding generations might see a Professor of Islam at Oxford. They were met at Tours in 732 by Charles Martel, Charles the Hammer—Charles the Smasher, if you like—and he inflicted a defeat which Creasy, who, I suspect, has often stood in this room, classes among the fifteen decisive battles of the world. It was a decisive battle. It stopped the progress of Islam in that direction. But what I want you to notice for my purpose is this: that was a defeat of a wing of the great Moslem army 2,000 miles away from its centre, because whilst Islam had been making progress in the direction I have spoken of, Constantinople had resisted two tremendous sieges where all the might of Islam and all the manhood of Arabia had been brought against it. The first was the famous siege of 670 that lasted five years. At the head of it was Sophian, which means Job. Job had been the standard-bearer of Mahomet, and in a certain sense you may say that he was the St. John of Mahomet, if you may make such a comparison. He was a young fellow when Mahomet died, an old man when in 670 he led the great Moslem army to the capture of the new Rome, as it was and is called throughout the East, "New Room," as it was called by our ancestors in the time of Shakespeare: "Now is there room indeed and room enough"; and even Pope makes "Rome" rhyme with "doom." The great object of the Moslems was to capture the new Rome because Mahomet had given his blessing to everybody who should take part in the attempt and had promised paradise to all who should die in it. Well, it was a determined attempt, but it failed. Siege was laid to the city for five years, but the stout walls that are still there were bravely defended by the men within, and Christianity was saved from a Moslem invasion at that time. Then in 770 there was the biggest attempt ever made to take Constantinople, when an army of 350,000 men with a fleet of 1,800 ships came to Constantinople and determined that, if they could, they would take it that time. They besieged it for seven years, and again they failed. The ships were mostly destroyed, and the great Arab host dispersed as refugees throughout the world. The saving of Europe and European civilisation was much more marked at Constantinople than it was in the battle of Tours. But our conceited fathers and grandfathers did not give any attention to its result on European history. It is a really very great point in the history of Constantinople and of the world.

Now we have Constantinople in a flourishing condition, and, in spite of little reverses, it is steadily going ahead. But there has begun already, when we get to 1000, a movement

which is going to be the ruin of the Empire. This irregular alternation of periods of drought and of moisture was bringing into Asia Minor from South-Central Asia a stream of Nomads. We know more of the history of the Turks during the centuries between 300 and 900 than we do of the Turks of that period. The researches that have been made during the last twenty-five years have brought to light numbers of facts that were before obscure, and Sir Charles Lyall from this platform had something to do towards bringing some of the most important to light.

A stream of Turks commenced to enter the country. They were Nomads, that is to say, gipsies. They had no house, they lived in their felt tents, they lived upon their cattle, they passed from one place to another as the necessities of pasture required. They came, and they were naturally opposed by the inhabitants of the country, who were the most civilised people in Europe at that time. The little streams tended to bring great numbers together who formed themselves into groups, and became a general nuisance to the inhabitants. The first of the great mass of the Turks who entered in that way into the country were the Seljuks. I may tell you at once that the history of the Seljuks has not yet been fully made out. They were undoubtedly the most civilised of any of the groups who emigrated from South-Central Asia into what is now Asia Minor.

Those of you who have seen the wonderful ruins that they have left, will be greatly puzzled to decide where they got their art from. It is not Persian art, still less is it—as I saw it was foolishly stated the other day—Hittite art. I have seen some of the famous monuments of the Hittites, and while one is crude and barbaric, the other has a touch of refinement about it which is extremely strange. Nor is it anything like the art that some of you may have seen represented in Berlin. Some dozen years ago the Sultan Abdul Hamed made a present to the Kaiser of a great mass of slabs, one of which is certainly as long as the side of this room. These slabs, with enormous labour and at a very heavy cost, were transported to Berlin without being broken, from Mashda, on the east of the Jordan, where they were found, and I believe a special room has since been built for them. They were in a temporary room when I saw them five years ago. Their art is very remarkable. I think the best opinion is that it is an art that belongs to a period within a century of Mahomet's death, *i.e.*, it was not influenced by the teaching of Mahomet. There seems to be no representation of any teaching of his, although it is crammed full of representation.

The Seljuks undoubtedly had very great courage. They came into the country in the tenth century, and before the eleventh century they had worked their way from Konia, which is in the centre of the great plain of Asia Minor, right down to within sight of the Marmora. They had taken possession of Nicaea, the city of the Nicene Creed, and they held it in 1097 when the first and the greatest of the Crusades under Godfrey de Bouillon went from Constantinople to Nicaea. A terrible siege took place. Hideous brutalities were committed by besiegers and besieged, and it ended in the Crusaders making an arrangement with the Emperor of Constantinople to take over the city, so that he prevented the Crusaders from lingering on the pursuit of the object of their lives, which was to get to Jerusalem.

I merely mention that to show how important the Seljuks had become within 150 years of their first appearance. The ambition of the Seljuks was the ambition of every other tribe—to push on towards the north-west from the plain and to occupy New Rome. They failed. Then the Turks were attacked again and again and again, and defeated again and again and again. You have a similar story in the Old Testament about the Philistines. They come on and are defeated, and a dozen verses farther on you will find that another lot of Philistines had come over from Cyprus or somewhere else, and are again defeated. They were defeated again and again, but the stream was always running from Central Asia, and the new Nomads were coming in. Then when we get to about the end of the thirteenth century—as a matter of fact it was 1298—you have numbers of new groups of Turks working in different parts of Asia Minor, seizing blocks of land for themselves and preying upon the inhabitants. At that time a specially strong one appeared under Osman or Othman, and these are the men who are known as the Ottoman Turks. As a matter of fact Osman was declared Sultan in that year. Then you have this group gathering to itself the smaller groups that were opposed to the Seljuks, and they ultimately constituted the strongest group of Turks in Asia Minor.

Then half a century later you get to the great institution which had so much to do with the development of the Turks. Was it an inspiration on anybody's part—if I had been lecturing here a century ago, or if I had been listening to a lecture a century ago, the speaker would probably have said that it was an inspiration of the devil, but it was a clever one all the same—to take toll of the Christian children in the country and to create an army out of the Christians exclusively, that should have no connection with the Christians, breaking them off from all connection with their families and making them into an army of Islam?

The new troops were formed in this way. Some of the Sulima called the attention of the Sultan to the fact that, by sacred law, the law of Mahomet, he had a right to one-fifth of the whole of the property of all the families of races that he had conquered. In the word property was included children; and presently it became one-third of all the male children. Within twenty years from 1355, when these new troops were formed, there was a large army to whom the name was given of "new troops," or in Turkish, janissaries. The *élite* of the population, the best-looking and the most intelligent of the sons of the Christian families were taken and formed into separate regiments, and they went through a discipline of the hardest possible character. They were taught to endure hardships, taught to be skilled with their weapons; they were cut off absolutely from their families; they were forcibly converted to Mohammedanism; they were taught that all their future prospects depended upon their rank in their regiment.

The result was that there were regiments which for drill, for discipline, for courage, and for bravery had never been surpassed since the time of the Roman Pretorian Guard. These janissaries were the conquering arm of the Mohammedan hordes, and they soon made their influence felt. From this time—say from 1400—during the next fifty years, was one long period of conquest between them and the inhabitants of the country, the stream always running into Asia Minor and bringing new men to them. The Christians might fight and win as many battles as they liked, but there would always be a larger army coming in after them. With these Christian soldiers at their head the Turks were becoming invincible. You have been reading in the papers this last day or two that a great battle is expected at Kossovopol. A very great battle occurred there in which the Serbians were entirely crushed, mainly by the janissaries, and a few years afterwards you read of the great battle of Varna. We have had Varna before us also within the last three or four weeks. I went down to Varna and spent a week there, in order that I might write the account of the battle, and I know the story pretty well. I cannot tell it now; time would fail me. But at Varna, which was fought in 1444, a blunder had been made by the Turks, the Sultan, Mahomet, a boy of fifteen or sixteen only, getting into an unfortunate position. They were surrounded by their enemies under the famous John Hunyady, a skilled general, a man who had taken part in the second battle of Kossovopol. The only troops to be relied upon were the janissaries, who were under the boy Mahomet. It is the famous place of the scrap of paper. I expect you all know the story about it; if you do not I will tell you it, because we have heard of scraps of paper in this part of the world, and it is to the credit of the Turks that this scrap of paper story tells. What happened was this. A treaty of perpetual peace had been made between the young Mahomet and Ladislaus, the King of Hungary, and each had signed it and sworn to it, the Turk on the Koran, the Christian on the gospels or the crucifix. In spite of good faith this was broken by the Christians, and when the battle took place young Mahomet ordered the treaty to be stuck on the head of a lance and carried in front of the janissaries.

The story tells—it may be true, it may not, but probably it is essentially true—that he prayed: "O Christ, if Thou art God, as thy followers believe, avenge me of this perfidy!" The Christians fell on the Turks, and suffered a tremendous defeat at the hands of the janissaries—at the hands of soldiers who had been born Christians. That is the story of the Varna scrap of paper. That was in 1444, and in 1453 you have the greatest triumph that the Turks ever achieved, when they captured Constantinople. I have written the fullest account of it—I do not say the best. Now what happened was this—you can read it all very well in Gibbon, it is perhaps Gibbon's finest chapter. On that fatal May 29th two attacks had been made against the city, and John Justinius, under the brave Emperor Constantine, had resisted manfully during the two attacks, the first of which commenced at one or half-past one in the morning. At last,

when the second attack had failed, the poor fellows thought, "Now there will be a respite, and the city will not be taken this time." Then, in the language of Gibbon, which I will not attempt to improve on, because I could not, at that fatal moment up rushed the janissaries, fresh, vigorous and invincible, and carried everything before them, and before seven o'clock in the morning they had taken possession of Constantinople—New Rome. The object of the Turks had been attained. But the Turks had not finished. They went on conquering and to conquer, and they conquered every inch of the Balkans until they had conquered also Hungary, and they laid siege in 1683 to Vienna itself. But their time had come. When they laid siege to Vienna in 1683 their hour had struck. John Sobieski relieved the city, and from that time to this the story of the Turks has been one long story of decadence and of disintegration.

I cannot even attempt, as my time is running on, to point out what an enormous empire the Turkish Empire was at that time—all North Africa, part of Persia, all South Prussia, every inch of territory in the Balkans. But if you had a series of maps beginning with 1683, and reproduced a new map every thirty years afterwards right away from that time down to the present, you would find each map smaller than its predecessor. The Turk's day had passed. The zenith was in 1683. I ask you to tell me where it is in 1915. I will not attempt to speak of it.

Now I must say something of the Turkish rule in Asia. The great fault of the Turk is that he has never succeeded in governing subject races. Lord Cromer declared that I had put my finger on the spot when I made that statement in a book that I had recently published. Turkey has never succeeded in ruling subject races. She could never be just to them; and if you want a ghastly story of it I must simply allude to the story of the Armenians, because I should keep you for another hour at least if I dealt with it in detail. The Armenians, all things considered, are the manliest race in Asia Minor. They are fine fellows physically. They come from that great central plain of Asia Minor. It begins in the Konia district at an elevation of 2,500 feet, and it rises steadily till you reach some 6,200 feet. You have it at Batoum, which is quite in the other direction, towards Alexandretta, which has always preserved a certain amount of independence. Abdul Hamed wanted some twenty years ago to exterminate every Armenian in Batoum, and a number of Ministers and others—I count myself happy to have been one of them—brought all the influence we could to bear upon every Ambassador in Constantinople, and we got a message to the Sultan to say that it would not be permitted. So the Armenians in Batoum were saved.

The Armenians are a strikingly interesting people. The point about them which I think would interest you most is the differences between them and the rest of the Christian population of Asia Minor. They have always been singularly independent. They accepted Christianity as the religion of the State before the Orthodox Church did. Their great saint, Saint Gregory the Illuminator, must have been a singularly remarkable man. Probably some of you do not know that the Armenians celebrate their Christmas Day, not on December 25th, but usually about January 15th. The explanation of that is a very curious and interesting one, which shows the character of the Armenian people. The Armenians have always been strong monotheists. You will recall that the three great monotheistic religions of the world, Judaism, Christianity and Islam, all come from that part of the world, from Syria or Arabia. At the time when Christianity was introduced and was beginning to spread, say in the first, second, and third centuries, the most popular form of Paganism in Asia Minor and all throughout South Arabia was Mithraism. If you go to the York Museum you will find traces of Mithraism there. Some of the soldiers in the Anatolian regiments were apparently Mithraists, and you can find the emblems on the tombstones that have been preserved. This Mithraism was a curious sort of creed. Tertullian, whose authority no one will dispute, writing in the second century, said: "Mithraism is a travesty of Christianity invented by the devil centuries before Christ was born in order to deceive the elect." The great feature of the independence of the Armenians that I want to call attention to is this: the birthday of Mithra was celebrated on December 25th. It is known to have been celebrated on that date three centuries before Christ. When the Western Church and the Orthodox Church also—not the Armenian Church—arranged their festivals, they said: "We will have nothing to do with that. This is a great feast. It is recognised by the whole of the followers of Mithra, and as

we cannot tolerate a Mithraic feast we must convert it into a Christian feast." The attitude of the Armenians, on the other hand, was: "We will not have anything to do with Mithraism. We will not celebrate the birth of Christ at the same time as the birthday of Mithra has been celebrated," and so they decided that Christmas Day should be celebrated at a different time. The decree has gone forth apparently that the Armenians are to be exterminated. Similar decrees have gone forward before this, but they are not yet exterminated.

Passing from them and returning to Constantinople, there is only one further matter to which I wish to direct your attention. I have spoken of the great roads which Justinian made by which he diverted the traffic from the Persian Gulf to the Bosphorus. Can Constantinople ever again become the great commercial city which it was, and continued to be, until the conquest by the Turks in 1453? In my opinion it is quite impossible, for various reasons. It attained that eminence centuries ago for the reasons that I have endeavoured to explain. The tendency of events, I will not say of physical causes, has been to diminish its importance as a commercial city. Steam has struck it a heavy blow. The opening of the Suez Canal has struck it a still heavier one. Steam rendered Constantinople as a commercial city this disservice. Up to that time Constantinople was a centre for the collection and distribution of merchandise. Small sailing vessels came from the islands and from all parts round the Marmora and Black Sea, the centre being Constantinople. Their goods were transferred into big ships, and they were taken to Western ports or even to Russia. That has passed away. Under steam the big steamer goes round and collects her goods, and this small traffic has disappeared. But a still greater hindrance to Constantinople recovering its ancient reputation is the opening of the Suez Canal. It is true that water carriage is always enormously cheaper than land carriage. The cost of transporting merchandise consists in what the French call *manutention* in the handling of the goods. If you are going to attempt to bring goods from India or from China to the Persian Gulf, then to discharge the ship and put the goods on board a train on the Baghdad Railway, for example, take them to Constantinople, and then take them out and put them on board another ship, you are engaging in a very costly process. The Turks have built very large hopes on the success of the Baghdad Railway. I have never opposed it. The Baghdad Railway will be an excellent thing for the country, but to suppose that it is going to draw towards it the traffic from India and from the East is to ignore facts. You cannot get over the difficulty that the handling of goods will always enormously increase the cost of transport. If the goods are heavy goods — and that is the case with most of them, such as rice, grain, coffee, and so on —the fact, if they are carried by water, that the voyage will take a few days longer, is a matter of very little account. If you are thinking of passengers, those who know the country—and the Chairman is one—will tell you at once that they are not particularly ambitious of making a journey across the hot plains of Mesopotamia in the summer weather, if they can get a P. & O. boat round by the Red Sea and the Canal. So I say that even supposing the Baghdad Railway will be completed, as it will be completed—it is nearly completed now—while the advantage to Asiatic Turkey will be great, there is nothing to be feared from the competition of Eastern trade; and anybody who thinks that the great bulk of the Eastern trade will be attracted through Turkey in that kind of way is a dreamer who ignores facts.

I have already detained you much longer than I had hoped to do. I have left unsaid many things which I should like to have said, but I hope I have given you an idea of the general condition of Turkey, so that you can add it to the store of ideas that you already possess.

DISCUSSION.

THE CHAIRMAN (Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.), in opening the discussion, said he wished to draw attention to one or two points upon which somewhat different views had recently been expressed from those given by the author. For instance, the rise and fall of the famous city of Palmyra had recently been very ably discussed in an excellent book by Sir Mark Sykes called "The Heritage of the Kaliphs," and he did not give the fact of the desiccation of the country south of Palmyra by any means as the chief reason for the decay of that city. He made some very caustic remarks on the subject of the greatness of Palmyra in her best days, and drew a somewhat unkind parallel between the best of the Palmyra ruins and the Hotel Cecil. The audience would have been able to appreciate very much more what Sir Edwin had said in regard to the position of the Justinian roads if a map had been exhibited on which the author could have pointed out exactly where they ran. With regard

to the rise of Mahomet, he did not think there was any necessity to appeal to any country further than Western Arabia for the mass of the men who followed him to victory right through Central Asia. At the beginning of things he certainly thought the whole of his army was purely Arabian. There was no doubt that when he got into Central Asia he began, as conquerors always did, to rope in the various tribes whom he had subjected, so that his army was swollen with a very large force of people who were not Arabian. But at the commencement he had no doubt that the backbone of Mahomet's army was Arabian. He would be very glad to have the author's opinion on the real cause of the decay of the Ottoman Empire. Sir Edwin had mentioned that the Ottomans pressed into their service the janissaries who were recruited and derived from Christian sources. There was no doubt that the strength of the army in the early days of the Ottoman Empire was derived from those so-called Christian forces. He believed that the Christians were not only brought up and educated as fighting men, but as administrators, and that for some two or three centuries at least the Ottoman Empire was largely administered by men who originally were Christians, in fact by men of the same stamp as those who were enlisted as janissaries. He knew of one authority who distinctly traced the decadence of the Ottoman Empire to a change of the administration which discarded the Christians and put the chief administrative powers into the hands of the Turks.

Mr. G. Hagopian said he had been told, and believed, that the early Emperors of the Turks were men of character and of justice, and it was justice that drew to their flag so many of the peoples of the races of the Near East. But a time arrived when justice gave place to tyranny, and the author had given particulars of how that tyranny had worked. It was impossible for a nation to prosper which massacred its subjects and its bread-winners, and those to whom it was beholden for its very existence. It was impossible to have in one nation two sorts of intelligence, two systems of justice, civilisation and progress the one contrary to the other, and it was due to pursuing that course that Turkey had come to its present position. He desired to ask the author, who had lived for forty years in Constantinople, and had been a practitioner before the Turkish courts as well as before the British Consular court, how many Turkish administrators had ever told him anything worth a penny about political economy, the wealth of nations, and all that made a country rich and prosperous. One could not understand the Armenian people unless their literature was compared with that of other communities. Certain parts of it bore the stamp of the greatest antiquity, and the language was one of the most powerful in the world. A nation which used such inspiring, eloquent and majestic language could never be suppressed. Personally, he was the master of several languages, so that he spoke from knowledge when he expressed that opinion — an opinion shared by one of the generals of the German army, who said to a Turkish officer at Versailles in 1870 that the Armenian language was the most expressive of the fourteen languages he knew, and that the declaration by the Emperor William to the princes and people of Germany in regard to the formation of the Empire should have been made in Armenian, as it was the only language suitable for such an occasion.

Mr. H. Charles Woods thought the misrule in Turkey was entirely due to the fact, as the author had stated, that the Turks could not rule, and never had understood how to rule. It was also due, at least in modern times, to the lack of road and railway construction. Had the Young Turks done something to prove the *bonâ fide* character of the Government to the people their position might have been quite different from what it was at the present time, and one of the best ways of doing that would have been to have carried out something in the way of public works. With reference to the question of the Armenian massacres, it was a most important point to bear in mind that when the massacres had taken place they were first of all by the order of the Central Government and then by the order of the local authorities. When the general order went out from Constantinople, it was carried out by the local authorities. The Turk might love to kill a Christian, but he did not massacre Armenians on a large scale without an order. That was an extremely important point at the present time, because it was an absolute proof that the dreadful massacres which had recently taken place could have been stopped by the Turks and by the Germans. Any little knowledge he personally possessed of the Near East and its peoples was largely the result of the tuition he had received from the author, to whom he was extremely grateful for his past and present help.

Sir Edwin Pears, in reply, said he entirely agreed with what Mr. Woods had said in reference to the Armenian massacres being by order. All the massacres between 1892 and 1898 were executed on the orders of Abdul Hamed. It was most important for the people of this country not to imagine that the massacres were due to an outbreak on the part of the Moslem population. It was nothing of the sort; it was due to the damnable character of Abdul Hamed. Abdul Hamed might at any time have stopped the massacres if he cared to do so. Lord Cromer had made practically the same remark, and he entirely agreed with him. Sir Mark Sykes in the book he had written mentioned how a Turk that he came across was heartily ashamed of the loathsome murders that were committed upon the Christians. It was most important that those murders

should not be put down to the Islam population, because in India there were great masses of perfectly loyal Islamic troops who did not back up the barbarism of Abdul Hamed and his satellites. He entirely sympathised with the remark made by Professor Morgan at a meeting held on the previous evening that English people often did not take sufficient credit to themselves for their virtues, and that the people in this country had the purest administration in Europe. The English race had the reputation throughout the whole of the East of being the one race that loved justice, a reputation they had held since the year 1100, when their ancestors and cousins went out there and were admired because of their love of justice. British people executed justice throughout the East, and for that reason were believed to be a justice-loving people. That was the finest character that could be given to a nation.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Sir Edwin Pears for his interesting and instructive paper, and the meeting terminated.

HOME INDUSTRIES IN THE HIGHLANDS AND ISLANDS OF SCOTLAND.

The problem of developing crafts and industries in the Scottish highlands and islands is one which at long intervals attracts the attention of the Government, and leads to an inquiry and the initiation of some new scheme, or the modification of some old scheme, for providing the crofters and their families with remunerative occupations which will enable them to supplement the bare living which they can extract from agriculture. The most recent inquiry was undertaken by Dr. W. R. Scott at the request of the Board of Agriculture for Scotland. His report deals with three main industries—tweed-making in Harris and the Hebrides generally, hosiery-knitting in Shetland, and kelp-making in Orkney, and, to a less extent, in the Hebrides. The information which follows is taken from the September number of the *Monthly Bulletin of Economic and Social Intelligence*, in which Dr. Scott's report is examined at some length. "Harris" tweed, or a tweed of the same type, is manufactured in the homes of the crofters in the islands of Harris, Lewis, North Uist, South Uist, and, to a small extent, on the mainland in the Western Highlands. In all the processes, except the actual weaving of the yarn, the majority of the workers are women, and in the production of the best cloth the only part of the work entrusted to machinery is the carding; all the other processes—washing, dyeing, spinning, weaving, and finishing—being carried out by hand. Spinning occupies the greater part of the time required for making the cloth, and the temptation to substitute machine-spun yarn for yarn spun by hand is for that reason very great, and such substitution is one of the chief difficulties which is encountered in any attempt to organise the industry. The workers who make the cloth dispose of it to local merchants, or sell it through a voluntary association for the encouragement of the industry, such as the Scottish Home Industries Association or the Crofters' Agency.

The average price paid in 1911 to the makers of the tweed was 3*s.* per yard, and the cloth sold retail at 4*s.* 6*d.* per yard. The nominal earnings of the women workers in the same year were about 10*s.* a week—a sum which represents a very substantial addition to the family income.

Hosiery-knitting in the Shetlands had a curious origin. The art was taught to the islanders by Spanish sailors, the survivors of a galleon belonging to the Armada, wrecked on Fair Island in 1588. The organisation of the industry is of the simplest type. The women knit in their spare time and accomplish most of the work in winter, though they knit industriously in summer in the open air whenever they have no other work which claims their attention. In some cases the wool is hand-carded and hand-spun, but in many cases one or both of these processes is performed by machinery. Shetland wool is of exquisite fineness, and machine-carding is considered by some of the workers to ruin the fine fibres. Shetland hosiery is always made in the natural colours of the wool; but Fair Island hosiery is dyed in bright colours, which, unfortunately, are not always harmonious. It is estimated that the women earn at the work from 4*s.* to 6*s.* a week, and though these earnings seem small it must be remembered that the women, when knitting and spinning, are really employing time which would otherwise remain unutilised, and that, as they can knit and chat with their friends and set their own pace in working, the fatigue is probably not great, and there is often even a balance of enjoyment in the work.

Kelp-making is not strictly speaking a home industry, but it is an industry in the same position inasmuch as it is supplementary to agriculture, and this is sufficient to justify its inclusion in Dr. Scott's report. Kelp is obtained by burning seaweed in the open air in specially-constructed kilns, or in shallow holes dug in the earth. The residue from the burning, while hot, is stirred into a glutinous mass which hardens on cooling into a greyish substance resembling coarse lava. In this form it is exported, being valuable chiefly for the iodine and potash salts which it contains. The industry was introduced into the Orkneys in 1722, and soon spread to North Uist and other islands in the Hebrides. The price obtained for the product has fluctuated in a remarkable manner. In the first years the price at times fell below £1 a ton, while during the war with France the price was as high as £20 a ton; and from 1800 to 1820 the average price was £10 10*s.* a ton. From 1840 to 1870 the industry was depressed; but since then it has recovered, and its prospects at the present time are distinctly good.

The Board of Agriculture for Scotland has wide powers in connection with the encouragement of domestic industries in the highlands and islands. Already it is doing much for the promotion of agriculture, and particularly for the encouragement of sheep-breeding, and this work indirectly assists the home industries by furnishing the workers with improved raw material; but Dr. Scott points out that this is not sufficient to secure the development of such industries. A broad scheme of technical instruction is necessary, and, by making the fullest possible use of the many voluntary committees and associations which exist and which are doing good work in promoting home industries, the cost of a scheme of instruction would not be unduly heavy. A number of minor home industries are carried on in various places in the highlands and islands. Lace-making is of some importance at Tarbert and New Pitsligo; basket-making is carried on at Portree and Kilmuir; and there is a small rug-making industry in Shetland. There are others—straw-plaiting, pottery and metal work—which are at present upon a very small scale indeed, but which might quite possibly be developed into industries of some size.

CORRESPONDENCE.

PAINTING AND PREVENTION OF RUST.

With regard to the article on the above subject in the *Journal* of November 19th, I am of the opinion that most manufacturers, etc., paint iron firstly with a coat of either red or grey lead paint, and then put the required coloured paint on in any number of coats desired. The lead paint evidently prevents the rust referred to.

D. R. BROADBENT.

NOTES ON BOOKS.

OLD LONDON'S SPAS, BATHS, AND WELLS. By Septimus Sunderland, M.D. London: J. Bale, Sons & Danielsson, Ltd. 7*s.* 6*d.* net.

Dr. Sunderland is an expert in Balneology, and this book is founded on his Address as President of the Balneological and Climatological Section of the Royal Society of Medicine. It is dedicated to the memory of Sir Edward Sieveking, the first Honorary President; Dr. Henry Lewis, of Folkestone, first President; and Dr. Samuel Hyde, of Buxton, first Chairman of Council of the British Balneological and Climatological Society, now incorporated with the Royal Society of Medicine. The main object of the society is to help towards the recognition of the value of the baths and waters of Great Britain, one of the most important questions of the day when invalids are confined to those of our own country. A committee of the section, in reply to the expressed wish of the military authorities, have prepared a pamphlet for the War Office, specifying "the various morbid conditions of our wounded and invalid sailors and soldiers requiring special treatment," together with a list of British health resorts indicated for their relief; with the gratifying result that many of the British spas have made special arrangements for the reception of military patients whose recovery would be hastened by the use of waters and baths.

This volume contains a valuable collection of notes on Old London spas, baths, and wells; but the classification is a little confused, and the distinction between the wells of pure water used for domestic purposes and the medicinal waters is not well defined. Moreover, some spas outside London are included. The list of the wells of Old London is, of course, only of archæological interest, as few of them are of any value now. It is, however, of considerable topographical interest.

Fitzstephen's remarkable description of London in the twelfth century contains a very alluring account of its abundant water supply: "The wells send up fountains of sweet and wholesome water, which glistens as it runs over the pebbles, the flowing streams and the pleasant clack of the watermills make music on all sides." We find this pleasant picture vouched for by the fact that gardens, the best in Old London, followed the course of the Walbrook for some centuries after the Roman domination. Stow says that "in every street and lane of the city are divers fair wells and fresh springs; and after this manner was the city then served, with sweet and fresh waters, which being since decayed, other means have been sought to supply the want."

When the wells ceased to give the inhabitants of London a sufficient water supply, the people were forced to depend upon the conduits and the tankard-bearers who brought the water to their houses. The tankards were wooden vessels, broad at the bottom but very narrow at the top. They were bound with iron hoops, and held about three gallons. Old maps show groups of these at various stations. In Agas's map of London the water-carriers are represented as drawing from the Thames at the Tower Stairs. These men were commonly called Cobs; so Ben Jonson named one of the characters in "Every Man in his Humour" Oliver Cob, a water-carrier, who lived "at the sign of the 'Water Tankard,' hard by the 'Green Lattice.'" Thames water continued pure for some centuries, in spite of the surface drainage into it.

The subject of this book may be divided under the following heads: (1) Holy Wells; (2) Spas and other Medicinal Wells; (3) Baths and Hot Baths.

(1) Holy Wells were mostly connected with certain religious houses. Two of the holy wells have given names to well-known streets. The one connected with Haliwell Priory, Shoreditch, was known before the foundation of this nunnery in the twelfth century, and Holywell Street, Strand, now passed away, was of considerable antiquity. Holy wells were seldom medicinal, although they may have been reputed to possess miraculous properties. The name of St. Chad (Ceadda), the patron saint of medicinal springs and wells, is

naturally associated with many springs. He was Bishop of Mercia, and settled his see at Lichfield, outside which place his well remains at Stow. His devotees who visited his shrine found his dust mingled with a little water to have a marvellous virtue in the cure of divers diseases.

St. Chad's Well in London was near Battle Bridge, not far from the site of the present King's Cross. St. Chad's Place keeps it in memory. It was supposed to have medicinal virtues, and pleasure gardens were attached to it; but it soon declined in public favour. Another St. Chad's well was situated at Shadwell, near Wapping. Lysons suggested that Shad was a variety of Chad. A Dr. Linden wrote a pamphlet to prove it could cure every disease. Others limited its virtues to the efficacy of the water in cutaneous diseases; but we cannot trust the doctors of the seventeenth and eighteenth centuries. The chapel of Our Lady of Muswell was famous as a place of pilgrimage, and the wells were believed to have miraculous virtues, but there is no evidence that they had any medicinal value. Another Lady well was at Brockley, and was said to be a holy well. Clerkenwell and Skinner's Well had great fame.

(2) Spas and other Medicinal Wells. When certain wells obtained fame by vigorous advertising, the proprietors found it worth their while to add the attraction of assembly rooms, so as to draw pleasure-seekers to their gardens; but although pump-rooms were added, there is little to make us believe that many of the visitors were troubled to drink the waters. The author, however, holds the opinion that in many instances the London spas were useful and valuable, and could be regarded as health resorts for country people as well as Londoners, "at a period when the undertaking of journeys was full of difficulty." Certainly in the eighteenth century South Lambeth was considered to be a health resort, and connections of the reviewer during the Napoleonic wars spent their holidays and drank the waters at Blackheath.

Some of the Old London spas had considerable repute, and the Hampstead Spa was one of the most popular. In 1698 the medicinal spring and six acres of land, known as the Wells Charity Estate, were presented to the poor of Hampstead by the Countess of Gainsborough and her son, and in 1700 an attempt was made to sell the water in flasks. New buildings in Well Walk were erected about 1701, containing an assembly room, a long room, and a pump-room. Dr. Gibbons asserted that the waters were "not inferior to any of our chalybeate springs, and coming very near Pyrmont in quality." The proprietor became bankrupt, and in 1725 the buildings were turned into a chapel. Two years afterwards an attempt was made to revive the spa, but with little success, although Dr. John Soame styled it "the inexhaustible fountain of health."

Marylebone Spa, opened in 1774 in Marylebone Gardens, had much success; but Dr. Sunderland is forced to condemn it as having been one of the spurious spas. Pancras Wells, Bagnigge Wells, New Tunbridge Wells, Islington, Sadlers Wells, Bermondsey Spa, and St. George's Spa were popular, but the frequenters of the gardens were often of a riff-raff character. Among the medicinal springs Cripplegate Well, Canonbury Springs, and Ladywell Springs had a certain repute. Mostly were chalybeate, some aperient. Beulah Spa was one of the latest. It was discovered in 1828, and continued until 1855. Magnesium sulphate is a common constituent of the waters of the Old London spas, and those containing sodium sulphate are frequently praised.

(3) Baths and Hot Baths form an interesting chapter in the history of London waters; but this is too large a subject to be treated here. The waters of St. Agnes le Clair Well, near Old Street, were deemed useful for skin and eye troubles.

Hummums and Bagnios were very popular for a time, but they died in disgrace, to be revived in our own days as Turkish baths. The old Roman Spring Bath at No. 5, Strand is one of the most interesting relics of Old London.

The vicissitudes of the early London water supply may be shortly indicated in the statement of a few dates. Stow tells us that water was first brought in pipes from Tyburn in 1236, and the great conduit in West Cheap was begun in 1285. Peter Morris pumped up Thames water by waterwheels in 1581. The New River was brought to London from the wells at Chadwell and Amwell, in Hertfordshire, and completed in 1613. In 1691 the York Buildings Waterworks Company was formed. The Chelsea Waterworks were established in 1723, and the Lambeth Waterworks in 1785. The Vauxhall Waterworks followed in 1805, the West Middlesex in 1806, and the Grand Junction in 1811.

Public pumps supplied by old wells were condemned after the severe visitation of cholera in 1866, and in 1875 there were only four in use—those at Aldgate, Bartholomew Lane, Crutched Friars, and Fann Street. They were soon after closed as dangerous to public health.

In conclusion, note may be made of the concluding chapter on "Modern Spa Treatment in Great Britain," in which the author enumerates the chief of these, and adds: "We possess mineral waters which are as useful as those of the Continental spas. In many of the above-mentioned places treatment can be carried out quite as efficaciously and satisfactorily as at foreign stations." One could wish that this chapter had been longer and fuller of information, for the utilisation of our medicinal waters as here indicated is a matter of immense national importance. Much has been done of late years. This volume contains many illustrations of interest. H. B. W.

Painting by Immersion and by Compressed Air. By Arthur Seymour Jennings, F.I.B.D. London: "The Managing Engineer," and E. & F. N. Spon, Ltd. 10*s*. 6*d*. net.

The substitution of immersion or the compressed-air process for the brush in the application of paint

has made great progress in the United States of America and in many parts of the continent. It is by no means unknown in this country. At Woolwich Arsenal, for instance, the plant for painting waggons, etc., has been in use for a dozen years, and has proved very successful, forty men being able to turn out as much work as the two hundred painters who were formerly employed there. But it seems clear that there is room for a very great extension of the process in Great Britain, for, under suitable conditions, it can effect immense saving both of time and labour. The author gives a list of some two hundred and fifty of the principal articles to which the process can be applied. These vary in size and nature from hooks and eyes to pianos and organs, and when it is added that a complete coat of enamel can be given to the body of a four-seated touring-car in two minutes, it will be seen that Mr. Jennings's handbook contains matter worthy the attention of all sorts and conditions of manufacturers.

With regard to the question whether paint applied by these methods is as durable as that applied by the brush, Mr. Jennings answers that when properly prepared it gives even better results, and has this additional advantage, that the paint finds its way into places which a brush could not reach, such as the open joints of a waggon, the intricate parts of certain agricultural machinery, and so forth.

The book is eminently practical. It describes the various kinds of tanks used, the hoists, trolleys, etc., the requirements of different trades, and the paints suitable for different kinds of work. There are also 150 illustrations, showing apparatus, methods of procedure, etc., and an excellent index.

GENERAL NOTES.

Memorial Tablets. — The London County Council have affixed a bronze tablet on No. 23, Highbury Place, the residence for some twenty years of the Chamberlain family. Joseph Chamberlain *senior* moved to this house in 1845, at which time the son was nine years of age. The Right Hon. Joseph Chamberlain was connected with two other houses in London—No. 188, Camberwell Grove, where he was born, and No. 40, Prince's Gardens, where he died—and it has been decided to erect tablets on each of these houses as well. A bronze tablet has also been affixed on No. 12, Park Crescent, where Lord Lister resided from 1877, when he first came to London as Professor of Clinical Surgery at King's College Hospital, till his death in 1912.

Ducks and Mosquitoes.—Ducks are among the greatest enemies of mosquitoes, and consequently of yellow fever and malaria. The *Colonial Journal* mentions an experiment carried out to prove their value in this particular. Two pools of equal area were made in a stream. Ducks were placed in one and fish in the other. The first was speedily cleared of mosquitoes, while the second continued to maintain the insects in all stages of development. Wild ducks were then introduced, and found to prefer the insects to all other foods. At the end of twenty-four hours no pupae were found in the pond, and after two days all the larvae had been destroyed. These experiments confirm the observations of William Lockwood, who found that the duck was particularly adapted to devouring the larvae on the surface of water, and of McAtee, who found mosquitoes in the gizzard of a wild duck.

The Trade of Khorasan of 1915.—The report on the trade of the large and important Persian province of Khorasan states that there is far greater opening for British trade than might have been inferred from recent reports. Russian goods reach Meshed, the capital of the province and most sacred city of Persia, by waggon in the course of a few days, while British and Indian goods, conveyed by pack animals by the Nushki trade route, take a period of never less than three and sometimes more than nine months. Were communications improved, thread, tissues, tobacco, cigarettes, wearing apparel, sugar, indigo, tanned and untanned hides, manufactured leather, drugs, carpets, mercury, hardware, and other goods from the United Kingdom and India might replace to a great extent the imports from other countries, and practically the whole of the carrying trade in Indian tea, much of which is at present carried by sea from India, would be secured for the Nushki route. One step towards the improvement of communications would be the establishment of a trustworthy and efficient forwarding agency between Meshed and Nushki. Again, the substitution of wheeled for pack transport along the greater part, if not the whole of the route, would remove another obstacle in the way of the expansion of British trade, and should be practicable with slight improvements to the road in places. What is most urgently required, however, is the extension of the railway to, or at least towards, the frontier. Nushki is twenty stages distant from the frontier, and the elimination of this tedious and arid route would greatly encourage trade.

Coir Mats in the Philippines.—The Industrial Division of the Bureau of Education at Manila has announced that commercial quantities of coir or coconut-husk mats of Philippine manufacture are now available for sale in the Philippines, and in the East generally, at prices which allow successful competition with American and European mats of this material. Raw material for the mats is to be had in abundance in the islands, of course, but the training of workmen for the manufacture of the mats has required time, and any wide development of the trade will require more time for that reason. The imports of such goods into China are considerable.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.

DECEMBER 1. — THE MASTER OF CHRIST'S COLLEGE, CAMBRIDGE (Arthur Everett Shipley, Sc.D., F.R.S.), "Insects and War." SIR WILLIAM J. COLLINS, K.C.V.O., M.S., F.R.C.S., will preside.

DECEMBER 8.—LIEUT.-COLONEL W. A. TILNEY, F.R.G.S., F.R.A.S., late 17th Lancers, "The Art of Finding your Way at Night without a Compass." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

DECEMBER 15.—J. JEF. DENYN, Carillonneur de Malines, and WILLIAM W. STARMER, F.R.A.M., "Carillons and Carillon Playing." (With illustrations.)

COLONIAL SECTION.

Tuesday afternoon, at 4.30 p.m. :—

NOVEMBER 30. — SIR SYDNEY OLIVIER, K.C.M.G., late Governor of Jamaica, "Recent Developments in Jamaica: Internal and External." SIR HENRY A. BLAKE, G.C.M.G., will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m. :—

DECEMBER 16.—C. C. MCLEOD, President of the London Jute Association, "The Indian Jute Industry." SIR JOHN PRESCOTT HEWETT, G.C.S.I., C.I.E., will preside.

Papers to be read after Christmas :—

PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

R. W. SETON-WATSON, D.Litt., "The Balkan Problem."

CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

LAWRENCE CHUBB, "The Common Lands of London: the Story of their Preservation."

REV. P. H. DITCHFIELD, "The England of Shakespeare."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

VICTOR HORTA, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

CHARLES DELCHEVALERIE, "Belgian Literature."

LESLIE URQUHART, "The Economic Development of Russia."

J. ARTHUR HUTTON, Chairman of the British Cotton Growing Association, "The Effect of the War on Cotton Growing in the British Empire."

S. CHARLES PHILLIPS, M.S.C.I., "Paper Supplies as affected by the War."

PROFESSOR T. G. MASARYK, "The Slavonic Peoples."

COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., late Survey of India, "The Romance of the Indian Ordnance Survey."

C. A. KINCAID, C.V.O., Indian Civil Service, "The Saints of Pandharpur."

SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

INDIAN SECTION.

Thursday afternoons at 4.30 p.m. :—

January 13, February 17, March 16, April 6, May 18.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m. :—

February 1, March 7, May 2.

CANTOR LECTURES.

Monday afternoons at 4.30 p.m. :—

WALTER ROSENHAIN, D.Sc., F.R.S., Superintendent, Metallurgy Department, National Physical Laboratory, "Optical Glass." Three Lectures.

Syllabus.

LECTURE I.—NOVEMBER 29.—Comparison of optical with ordinary glass—Defects and properties of glass for optical purposes — Transparency—Colour—Bubbles and defects — Striæ or veins—Internal strain and annealing — Hardness and durability—Testing of optical glass—The optical properties of glass—Refraction and dispersion—Their relation in crown and flint glasses—Glasses introduced by Schott and Abbe—Partial dispersions and the secondary spectrum—Apochromatic glasses and lenses.

LECTURE II.—DECEMBER 6.—History of optical glass manufacture — Fraunhofer, Guinand, Feil, Bontemps, Chance—Schott and Abbe—Hopkinson and Stokes—Efforts in England. The present method of optical glass manufacture—The furnace —The pot—Production and treatment—The process of melting and fining—Stirring and finishing —Cooling—Breaking up, selecting and moulding —Annealing—The final form of the glass.

LECTURE III.—DECEMBER 13.—The present process of manufacture—General difficulties—Costliness—Cost of the pot—Time of production—Cost of melting—Raw materials—Low yield of good glass—Risks of the process—Risks of loss during melting—Failures due to striæ—Risks of contamination—Errors and variations of optical constants—Range of glasses demanded by opticians—Small quantities required—Need for large stock of optical glass. Special difficulties in England—Cost of raw materials and of labour—Refractories. Special difficulties connected with "new" glasses—Their chemical activity—Action on pots—Absorption of colouring impurities—Attainment of extreme optical properties. Need for research—The general problem—How to make good optical glass—Necessary improvements in pots and refractories, and in furnaces and methods of working—Utilisation of new materials and electric methods—The special problems relating to individual types of glasses—Optical and other properties to be realised simultaneously—The limitations of possible glasses—Optical properties of crystalline media—Future possibilities.

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m.:—

REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "Flemish Architecture." Three Lectures.

February 7, 14, 21.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

JUVENILE LECTURES.

These Lectures will be given on Wednesday afternoons, January 5 and 12, at 3 p.m. The first lecture will be given by Professor John Millar Thomson, LL.D., F.R.S., on "Crystallisation," and the second by Mr. James Swinburne, F.R.S., on "Science of some Toys."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 29...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Mr. W. Rosenhain, "Optical Glass."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Sir Charles Metcalfe, "The Railway Development of Africa, Present and Future."

Actuaries, Institute of, Staple Inn Hall, Holborn, W.C., 5 p.m.

TUESDAY, NOVEMBER 30...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Sir Sydney Olivier, "Recent Developments in Jamaica: Internal and External."

Sociological Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Mr. A. E. Zimmern, "Nationality and Government."

Roman Studies, Society for the Promotion of, at the Royal Society, Burlington House, W., 4.30 p.m. Mr. G. McN. Rushforth, "Funeral Lights in Roman Sepulchral Monuments."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. 1. Mr. D. E. Lloyd-Davies, "Harbour and Coast-Defence Works at Alexandria." 2. Mr. C. A. Trery, "Galvan Port, Bahia Blanca, Argentine."

Photographic Society, 35, Russell-square, W.C., 8 p.m. Mr. H. W. Fincham, "Ely Cathedral."

WEDNESDAY, DECEMBER 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. The Master of Christ's College, Cambridge (Arthur Everett Shipley), "Insects and War."

Geological Society, Burlington House, W., 8 p.m.

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Dr. G. D. Lander, "The Microchemistry of some Alkaloids." 2. Mr. W. Partridge, "The 'Presumptive Coli Test' on Unchilled Water." 3. Mr. E. R. Bolton, "Notes on Methods of Analysing Oleaginous Seeds and Fruits."

Entomological Society, 11, Chandos-street, W., 8 p.m.

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. J. C. Hannah, "Irish Cathedrals."

Sanitary Engineers, Institute of, Caxton Hall, Westminster, S.W., 8 p.m. Dr. W. E. Adeney, "The Disposal of Sewage by Dilution: a Bio-Chemical Method."

THURSDAY, DECEMBER 2...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Chemical Society, Burlington House, W., 8 p.m. 1. Mr. P. Blackman, "A comparative method for determining vapour densities." (Continued.) 2. Messrs. O. L. Brady and F. P. Dunn, "The Isomerism of the oximes. Part VII.—5-Bromvanillinaldoxime, 5-nitrovanillinaldoxime and 6-nitropiperonaldoxime. 3. Mr. A. Slator, "The rate of growth of bacteria." 4. Mr. A. Bramley, "The study of binary mixtures. Part I.—The densities and viscosities of mixtures containing phenol." 5. Messrs. R. H. Callow, W. C. McC. Lewis, and G. Nodder, "Studies in catalysis. Part III.—Preliminary measurements of the infra-red absorption spectra of hydrogen chloride, potassium chloride, and methyl acetate in aqueous solution." 6. Mr. R. O. Griffith, "Studies in catalysis. Part IV.—Stoichiometric and catalytic effects due to the progressive displacement of one reactant by another in the 'acid' hydrolysis of methyl acetate." 7. Mr. A. K. Macbeth, "Colorations produced by some organic nitrocompounds with special reference to tetranitromethane." (Part II.) 8. Mr. S. G. Sastry, "The catalytic bleaching of palm-oil." 9. Messrs. W. A. Haward and T. Otagawa, "The propagation of flame in mixtures of hydrogen and air. The 'uniform movement.'"

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. A. H. Blake, "Samuel Pepys and his Times."

FRIDAY, DECEMBER 3...Geologists' Association, University College, W.C., 8 p.m.

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FRIDAY, DECEMBER 3, 1915.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 6th, at 4.30 p.m. (Cantor Lecture.) WALTER ROSENHAIN, D.Sc., F.R.S., Superintendent, Metallurgy Department, National Physical Laboratory, "Optical Glass." (Lecture II.)

WEDNESDAY, DECEMBER 8th, at 4.30 p.m. (Ordinary Meeting.) LIEUT.-COLONEL W. A. TILNEY, F.R.G.S., F.R.A.S., late 17th Lancers, "The Art of Finding your Way at Night without a Compass." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday afternoon, November 29th, DR. WALTER ROSENHAIN, F.R.S., delivered the first lecture of his course on "Optical Glass."

The lectures will be published in the *Journal* during the Christmas recess.

COLONIAL SECTION.

Tuesday afternoon, November 30th; SIR HENRY A. BLAKE, G.C.M.G., in the chair. A paper on "Recent Developments in Jamaica: Internal and External," was read by SIR SYDNEY OLIVIER, K.C.M.G., late Governor of Jamaica.

The paper and discussion will be published in a subsequent number of the *Journal*.

JUVENILE LECTURES.

Two of the Members of the Council—Professor John Millar Thomson, LL.D., F.R.S., and Mr. James Swinburne, F.R.S. — have kindly undertaken to deliver the Juvenile Lectures this year. Professor Thomson will give the first lecture on Wednesday afternoon, January 5th, at 3 p.m., his subject being "Crystallisation." Mr. James Swinburne will give the second on Wednesday, January 12th, at 3 p.m.; his subject will be "Science of some Toys." Both lectures will be very fully illustrated with experiments.

Special tickets are required for these lectures. They can be obtained, when ready, on application to the Secretary.

A sufficient number of tickets to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to a ticket admitting two children and one adult. Fellows who desire tickets are requested to apply for them at once.

PROCEEDINGS OF THE SOCIETY.

THIRD ORDINARY MEETING.

Wednesday, December 1st, 1915; SIR WILLIAM J. COLLINS, K.C.V.O., M.S., F.R.C.S., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Fakira, Meherali Mahomed, 13, Esplanade-road, Bombay, India.

Lyster, Anthony George, M.Eng., M.Inst.C.E., 2, Queen Anne's-gate, S.W.

Phelps, William Heath, J.P., Park House, 13, Park-street, Calcutta, India.

Stewart, William Arnold, Bulak Technical School, Cairo, Egypt.

The following candidates were balloted for and duly elected Fellows of the Society:—

Alexander, Alexander, National Gum and Mica Company, 59th Street and 11th Avenue, New York City, U.S.A.

Ardaseer, J. Grenville, Worli Hill, Bombay, India, and Olney House, Richmond, Surrey.

Audy, Alphonse William, 33, Civil Lines, Poona, India.

Baldwin, Mrs. Edith Brake, 24, Avenue-road, Leamington Spa.

Basu, Narendra Kumar, 99, Upper Circular-road, Calcutta, India.

Bhattacharyya, Jyotischandra, M.A., B.L., Purnea Bihar, India.

Bloxam, John Astley, F.R.C.S., J.P., The Old Malt House, near Maidenhead, Berks.

Buckley, Edward S., jun., 2039, Sansom-street, Philadelphia, Pa., U.S.A.

Cardona, Joseph M., 1917, Catamarca-street, Rosario, Argentine Republic.

Chance, Clinton Frederick, B.A., 12, Arthur-road, Edgbaston.

Chu Ju, General, Chiang Chun Yamen, Chekiang, China.

Clark, The Hon. Sir William Henry, K.C.S.I., C.M.G., Windcliffe, Simla, India.

Cochin, The Diwan of (Joseph W. Bhore, B.A., I.C.S.), Ernakulam, Cochin, South India.

Davson, Edward R., 20, Ennismore-gardens, S.W.

Dholpur, His Highness the Maharaj Rana of, Dholpur State, India.

Evans, Gerald A., LL.B., J.P., P.O. Box 151, Pietersburg, N. Transvaal, South Africa.

Furness, Horace Howard, jun., 2034, De Lancey-place, Philadelphia, Pa., U.S.A.

Gibbs, A. E., Pennsylvania Salt Manufacturing Company, Greenwich Point, Philadelphia, U.S.A.

Gwalior, Major-General His Highness The Maharaja of (Sir Madho Rao Sindhia Bahadur), G.C.S.I., G.C.V.O., LL.D., A.D.C., Madho Bilas, Sipri, Gwalior, India.

Ingels, Lionel, 5, Grosvenor House, Calcutta, India.

Lambagraon, Lieut.-Colonel the Hon. Raja Jai Chand of, C.S.I., Lambagraon, Kangra District, Punjab, India.

Leech, Arthur John, The Palms, College-road, Madras, India.

Liebert, William Ernest Cato, Messrs. Huttenbach Bros. & Co., Penang, Straits Settlements.

Lord, James Spain, Dover House, Bridge-street, Canterbury.

McCorry, Joseph James, 73, University-avenue, Belfast.

Miln, David Anderson, LL.B., M.A. (Edin.), 30, Greencroft-gardens, South Hampstead, N.W.

Mitchell, Alfred H., M.I.Mech.E., Port of London Authority, Elevator Dock, Silvertown, E.

Musgrave, Henry Arthur Fitzherbert, United Service Club, Calcutta, India.

Naidu, P. N. Muthuswami, B.A., Pagadala Bagh, Saidapet, Madras, India.

O'Callaghan, Major-General Sir Desmond D. T., R.A., K.C.V.O., 53, Iverna-court, Kensington, W.

Pite, Professor Arthur Beresford, F.R.I.B.A., 21, Willow-road, Hampstead, N.W.

Renult, William, 141, Broadway, New York City, U.S.A.

Showers, St. George, 32, Elm Park-road, S.W.

Singh (of Kapurthala), Sirdar Charanjit, Chadwick, Simla, India.

Singh, Rai Bahadur Choudri Amar, P.O. Pali, Dist. Bulandshare, United Provinces, India.

Smith, Alexander, 21, Oakshaw-street, Paisley, Scotland.

Smith, Lieut.-Colonel Thomas, V.D., The Muir Mills Co., Ltd., Cawnpore, India.

Sundaracharlu, S. K., M.A., Tahsildar, Tindivanam, South India.

Thorne, Mathew Henry, Rua Padrão, Vallongo, Portugal.

Vanderlip, Frank Arthur, A.M., LL.D., National City Bank, New York City, U.S.A.

The Chairman, in opening the meeting, announced that the Master of Christ's College, Cambridge, was unfortunately too ill to read his paper himself. Thanks, however, to the kind intervention of Mr. F. M. Howlett, who was Pathological Entomologist to the Government of India, the members would have the benefit of hearing Dr. Shipley's paper read and seeing the slides which illustrated it. Mr. Howlett was an excellent substitute for the original lecturer, as he had a world-wide reputation on the subject of parasitology.

The paper read was—

INSECTS AND WAR.

By Arthur Everett Shipley, Sc.D., F.R.S.,
Master of Christ's College, Cambridge.

The insects which prove such a nuisance to the fighter in time of war are the insects which equally affect man in time of peace. But owing to the different circumstances which arise when men are at war their effects are more violent and more persistent. Roughly speaking, we can divide these insect pests into two categories—(1) those which pierce the skin of men or of animals on which the soldier is to a great extent dependent, for instance, the horse; and (2) those which interfere with his food supplies. The latter, again, fall into two categories—(*a*) those which materially and substantially diminish that food supply, and by leaving their larvæ behind in the diminished stock render the food unpalatable; and (*b*) those which infect the food supply with pathogenic germs, such as those of enteric fever.

Amongst the insects which bite man, or, rather, pierce his skin, and which in times of peace can be kept in some sort of control, is the louse. In times of war, when men are herded together, with little or no opportunity of changing their linen, or washing, the louse is sure to appear and probably spread rapidly.

We will confine our attention to the genus *Pediculus*—*P. capitis*, the head-louse, and *P. vestmenti*, the body-louse. They do not arise, as the uninformed think, from dirt, though they flourish best in dirty surroundings. No specimen of *P. vestimenti* exists which is not the direct product of an egg laid by a mother-louse and fertilised by a father-louse. In considerable collections of men drawn from the poorer classes, some unhappy being or other—often through no fault of his own—will turn up in the community with lice on him, and these swiftly spread to others.

Like almost all animals lower than the mammals, the male of the body-louse is smaller and feebler than the female. The former attains a length of about 3 mm., and is about 1 mm. broad. The female is about 3·3 mm. long and about 1·4 mm. broad. It is rather bigger than the hair-louse, and its antennæ are slightly longer. It so far flatters its host as to imitate the colour of the skin upon which it lives; and Andrew Murray gives a series of gradations between the black louse of the West African and Australian native, the dark and smoky louse of the Hindu, the orange of the Africander and of the Hottentot, the yellowish-brown of the North and South American Indians, and the paler brown of the Esquimo, which approaches the light dirty-grey colour of the European parasites—

"As plump an' grey as onie grozet,"

as Burns has it.

The body-louse was the species dealt with in the recent observations undertaken by Mr. C. Warburton in the Quick Laboratory at Cambridge, at the request of the Local Government Board, the authorities of which were anxious to find out whether the flock used in making cheap bedding was instrumental in distributing vermin. Mr. Warburton at once appreciated the fact that he must know the life-history of the insect before he could successfully attack the problem put before him. At an early stage of his investigations he found that *P. vestimenti* survives longer under adverse conditions than *P. capitis*, the head-louse.

The habitat of the body-louse is that side of the underclothing which is in contact with the body. The louse, which sucks the blood of its host at least twice a day, is, when feeding, always anchored to the inside of the underclothing of its host by the claws of one or more of its six legs. Free lice are rarely found on the skin in western Europeans. But the underside of a stripped shirt is often alive with them.

After a great many experiments, Mr. Warburton succeeded in rearing these delicate insects, but only under certain circumscribed conditions; one of which was their anchorage in some sort of flannel or cloth, and the second was proximity to the human skin. He anchored his specimens on small pieces of cloth, which he interned in small test-tubes plugged with cotton-wool, which did not let the lice out, but did let air and the emanations of the human body in. For fear of breakage the glass tube was enclosed in an outer metal tube, and the whole was kept both night and day near the body. Two meals a day were necessary to keep the lice alive. When feeding, the pieces of cloth, which the lice would never let go of, were placed on the back of the hand, hence the danger of escape was practically *nil*, and once given access to the skin the lice fed immediately and greedily.

His success in keeping lice alive was but the final result of many experiments, the majority of which had failed. Lice are very difficult to rear. When you want them to live they die, and when you want them to die they live and multiply exceedingly. A single female but recently matured was placed in a test-tube, and a male admitted to her on the second day. The two paired on the sixth day, and afterwards at frequent intervals. Very soon after pairing an egg was laid, and during the remaining twenty-five days of her life the female laid an average of five eggs every twenty-four hours. The male died on the seventeenth day, and a second male was then introduced, who again paired with the female. The latter, however, died on the thirtieth day, but the second male survived.

The difficulty of keeping the male and female alive was simple compared with the difficulty of rearing the eggs. Very few hatched out. The strands of cloth upon which they were laid had been carefully removed and placed in separate tubes, at the same time being subjected to different temperatures. It was not, however, until the eggs were left alone undisturbed in the position where they had been laid and placed under the same conditions that the mother lived in that eight, and only eight, of the twenty-four eggs laid on the cloth hatched out after an incubation period of eight days. The remaining

sixteen eggs were apparently dead. But the tube in which they were was then subjected to the normal temperature of the room at night (on occasions this fell below freezing-point), and after an incubation period of upwards of a month six more hatched out. Hence it is obvious that, as in the case of many other insects, temperature plays a large part in the rate of development, and it becomes clear that the eggs or nits of *P. vestimenti* are capable of hatching out up to a period of at least from thirty-five to forty days after they are laid.

Difficult as it was to keep the adults alive, and more difficult as it was to hatch out the eggs, it was most difficult to rear the larvæ. Their small size made them difficult to observe, and, like most young animals, they are intolerant of control, apt to wander and explore, and less given to clinging to the cloth than their more sedentary parents. Naturally, they want to scatter, spread themselves, and pair.

Like young chickens, the larvæ feed immediately on emerging from the egg. They apparently moult three times, at intervals of about four days, and on the eleventh day attain their mature form, though they do not pair until four or five days later.

Mr. Warburton summarises the life-cycle of the insects, as indicated by his experiments, as follows: Incubation period, eight days to five weeks; from larva to imago, eleven days; non-functional mature condition, four days; adult life—male, three weeks; female, four weeks.

But we must not forget that these figures are based upon laboratory experiments, and that under the normal conditions the rate may be accelerated. From Mr. Warburton's experience it is perfectly obvious that, unless regularly fed, body-lice very quickly die. Of all the verminous clothing sent to the Quick Laboratory, very little contained *live* vermin. The newly-hatched larvæ perish in a day and a half unless they can obtain food. These facts regarding the life-history of body-lice were fully confirmed by Dr. Fantham when working on the protozoal parasites of lice.

With regard to the head-louse—

> "Ye ugly, creepin', blastit wonner,
> Detested, shunn'd by saunt an' sinner,"

it is smaller than the body-louse, and is of a cindery-grey colour. The female measures 1·8 mm. in length and 0·7 mm. in breadth. Like the body-louse, it varies its colour somewhat with the colour of the hair on the different branches of the human race. It lives amongst the hair of the head of people who neglect their heads; it is also, but more rarely, found amongst the eyelashes and in the beard. The egg, which has a certain beauty of symmetry, is cemented to the hair, and at the end of six days the larvæ emerge, which, after a certain number of moults, become mature on the eighteenth day. The methods adopted by many natives of plastering their hair with coloured clay, or of anointing it with ointments, probably guards against the presence of these parasites. The Spartan youths, who used to oil their long locks before going into battle, may have feared this parasite. Some German soldiers, before going to war, shave their heads; thus they afford no nidus for *P. capitis*. The wigs worn in the late seventeenth and at the beginning of the eighteenth centuries undoubtedly owed something to the difficulty of keeping this particular kind of vermin down. The later powdering of the hair may have been due to the same cause.

P. capitis is in wartime less important than *P. vestimenti*. The former certainly causes a certain skin trouble, but the latter not only affords constant irritation, but, like most biting insects, from time to time conveys most serious diseases. *P. vestimenti* is known to be the carrier of typhus. This was, I believe, first demonstrated in Algeria, but was amply confirmed last year in Ireland, when a serious outbreak of this fever took place, though little was heard of it in England. Possibly, *P. capitis* also conveys typhus, but undoubtedly both convey *Spirochaeta recurrentis*—the cause of relapsing or recurrent fever. The irritation due to the body-louse weakens the host and prevents sleep, besides which there is a certain psychic disgust which causes many officers to fear lice more than they fear bullets. Also by rubbing or scratching the lice may be crushed on the skin. The germs of disease within them may thus be inoculated directly into the blood through the surface of the skin damaged by the scratch. Soldiers should, further, always avoid touching their eyes after scratching insect-bites. Lice are the constant accompaniment of all armies; and in the South African War as soon as a regiment halted they stripped to the skin, turned their clothes inside out and picked the *Anoplura* off. As a private said to me: "We strips and we picks 'em off and places 'em in the sun, and it kind o' breaks the little beggars' 'earts!"

There were serious outbreaks of typhus during the recent Balkan wars among the combatants, prisoners, and refugees. The epidemics were spread by lice. Again, typhus and relapsing fever are endemic in various areas along the

eastern front of the present theatre of war, and are even now causing trouble in Serbia.

Another insect which pierces the skin of man and destroys the continuity of his integument is the bed-bug, *Cimex lectularius.*

The common bed-bug seems to have arrived in England about the same time as the cockroach, that is, over four hundred years ago, early in King Henry VIII.'s reign. Apparently it came from the East, and was for many years confined to seaports and harbours. It seems to have been first mentioned by playwriters towards the beginning of the seventeenth century. The sixteenth-century dramatists could never have resisted mentioning the bug had it been in their time a common household pest. It would have appealed to their sense of humour.

How the insect got the name of "bug" is unknown. It has been suggested that the Old English word "bug," meaning a ghost or phantom which walked by night, has been transferred to *Cimex.* This may be so, but the "Oxford English Dictionary" tells us that proof is lacking.

The insect is some 5 mm. in length, and about 3 mm. in breadth, and is of a reddish- or brownish-rusty colour, fading into black. Its body is extraordinarily flattened, so that it can readily pass into chinks or between splits in furniture and boarding, and this it does whenever daylight appears, for the bug loves darkness rather than light. The head is large, and ends in a long, piercing, four-jointed proboscis, which forms a tube with four piercing stylets in it. As a rule, the proboscis is folded back into a groove, which reaches to the first pair of legs on the under surface of the thorax. This folding back of the proboscis gives the insect a demure and even a devout expression; it appears to be engaged in prayer, but a bug never prays. The head bears two black eyes and two four-jointed antennæ. Each of the six legs is provided with two claws, and all the body is covered with fairly numerous hairs. The abdomen shows seven visible segments and a terminal piece.

The bug has no fixed period of the year for breeding; as long as the temperature is favourable and the food abundant generation will succeed generation without pause. Should, however, the weather turn cold the insects become numbed and their vitality and power of reproduction are interrupted until a sufficient degree of warmth returns.

Like the cockroach, the bed-bug is a frequenter of human habitations, but only of such as have reached a certain stage of comfort. It is said to be comparatively rare in the homes of savages; but it is only too common in the poorer quarters of our great cities. The iron bedstead which has so rapidly replaced the wooden bedstead was at one time thought to render the bug's position untenable. This is not so. Bugs will shelter in its metallic crevices almost as comfortably as in the wooden chinks of its predecessor. Its presence does not necessarily indicate neglect or want of cleanliness. It is apt to get into trunks and luggage, and in this way may be conveyed even into the best-kept homes. It is also very migratory, and will pass readily from one house to another, and when an infested dwelling is vacated these insects usually leave it for better company and better quarters. Their food supply being withdrawn, they make their way along gutters, water-pipes, etc., into adjoining and inhabited houses. *Cimex* is particularly common in ships, especially emigrant ships, and, although unknown to the aboriginal Indians of North America, it probably entered that continent with the "best families" in the "Mayflower."

Perhaps the most disagreeable feature of the bed-bug is that it produces an oily fluid which has a quite intolerable odour; the glands secreting this fluid are situated in various parts of the body. The presence of such glands in free-living Hemipterous insects is undoubtedly a protection—birds will not touch them. One, however, fails to see the use of this property in the bed-bug. At any rate, it does not deter cockroaches and ants, as well as other insects, from devouring the *Cimex.* There is a small black ant in Portugal which is said to clear a house of these pests in a few days; but one cannot always command the services of a small black Portuguese ant.

Another remarkable feature is that the insect has no wings, although in all probability its ancestors possessed these useful appendages. As the American poet writes—

> "The Lightning-bug has wings of gold,
> The June-bug wings of flame,
> The Bed-bug has no wings at all,
> But he *gets* there all the same!"

The power of "getting there" is truly remarkable. Man, their chief victim, has always warred against bugs, yet, like the poor, bugs "are always with us." I heard it stated, when I was living in Southern Italy, that if you submerged the legs of your bed in metal saucers full of water and placed the bed in the centre of the room,

the bugs will crawl up the wall, walk along the ceiling and drop on to the bed and on to you. Anyhow, whether this be so or not, there is no doubt that these insects have a certain success in the struggle for life, and only the most systematic and rigorous measures are capable of ridding a dwelling of their presence.

The eggs of the bed-bug are pearly white, oval objects, perhaps 1 mm. in length. At one end there is a small cap surrounded by a projecting rim, and it is by pushing off this cap, and through the orifice thus opened, that the young bug makes its way into the outer world after an incubation period of a week or ten days. There is no metamorphosis—no caterpillar and no chrysalis stages. The young hatch out in structure miniatures of their parents, but in colour they are yellowish-white and nearly transparent. The young feed readily, and feeding takes place between each moult, and the moults are five in number, before the adult imago emerges. This it does about the eleventh or twelfth week after hatching. These time-limits depend, however, upon the temperature after hatching, and the rate of growth depends not only upon the temperature, but also upon the amount of food.

When bred artificially, and under good conditions, the rate of progress can be "speeded up" so that the eggs hatch out in eight days, and every following moult takes place at intervals of eight days, so that the period from egg to adult can be run through in as short a time as seven weeks. Unless fed after each moult, the following moult is indefinitely postponed. Hence it follows that in the preliminary stages bugs must bite their hosts five times before the adult form emerges, and the adult must, further, have a meal before she lays her eggs. The eggs are deposited in batches of from five to fifty in cracks and crevices, into which the insects have retired for concealment.

Bugs can, however, live a long time without a meal. Cases are recorded in which they have been kept alive for more than a year incarcerated in a pill-box. When the pill-box was ultimately opened, the bugs appeared to be as thin as oiled paper, and almost so transparent that you could read the *Times** through them; but even under these conditions they had managed to produce offspring. De Geer kept several alive in a sealed bottle for more than a year. This power of existing without food may explain the fact that vacated houses occasionally swarm with bugs even when there have been no human beings in the neighbourhood for many months.

* Only the larger print, such as the leading articles and letters from admirals.

The effect of their bite varies in different people. As a rule, the actual bite lasts for two or three minutes before the insect is gorged, and at first it is painless. But very soon the bitten area begins to swell and to become red, and at times a regular eruption ensues. The irritation may be allayed by washing with menthol or ammonia.

The bed-bug has been accused of conveying many diseases. How far it does this in nature seems uncertain. But it certainly contains certain pathogenic spirochaetes, and monkeys have been infected in the laboratory with these.

In India the bed-bug is under suspicion of spreading *kala-azar*, or "black fever." Other insects probably convey similar diseases in various parts of the tropics and sub-tropics, as is indicated by the recent experiments of Professor Laveran and Dr. Franchini in Paris, and Drs. Fantham and Porter in Cambridge. Whether bugs be guilty of these crimes or not, they are the cause of an intense inconvenience and disgust, and should, if possible, be dealt with drastically. At the present time there are rumours that some of our largest camps are infested with these insects, and there seems no doubt that some of the prisoners and refugees to this country have brought their fauna with them, and this fauna is very capable of spreading in concentration camps. The erection of wooden huts—no doubt a pressing necessity—affords convenient quarters for these pests.

A third biting insect is the flea.

Fleas are temporarily parasitic on many mammals and birds, but some mammals and some birds are much freer from fleas than others. As the flea is only on its host for part of the time, it has to put in the rest of its existence in some other place, and this, in the case of the human flea, is usually the floor, and in the case of bird-fleas the nest; from these habitats they can easily regain their hosts when the latter retire to rest. But larger numbers of Ungulates—deer, cattle (except when domesticated), antelopes, goats, wild boars—usually sleep in different places each recurrent night, and to this is probably due the fact that, with the exception of two rare species—one taken in Northern China and the other in Transcaucasia—the Ungulates have furnished descriptive science with no fleas at all. Both of these Ungulate fleas are allied to the burrowing-fleas, or "chigoes."

I know none of my hearers will believe me

when I say that the same is true of monkeys; but I do this on the undoubted authority of Mr. Harold Russell, who has recently published a charming little monograph on these lively little creatures. Monkeys in nature are cleanly in their habits; and although in confinement occasionally a human flea attacks them, and although a chigo bores sometimes into the toes of a gorilla or chimpanzee, "speaking generally, it may be said that no fleas have been found truly parasitic on monkeys." Whatever the monkeys are looking for, it is not the fleas. What they seek is, in effect, little scabs of scurf, which are made palatable to their taste by a certain sour sweat.

As a rule, each host has its own species of flea, but though, for the most part, *Pulex irritans* is confined to man it is occasionally found on cats and dogs, whilst, conversely, the cat and dog fleas (*Ctenocephalus felis* and *Ct. canis*) from time to time attack man.

The bite of the flea is accompanied by the injection of the secretions of the so-called salivary glands of the insect, and this secretion retards the coagulation of the victim's blood, stimulates the blood-flow, and sets up the irritation we have all felt.

It is only a few years ago that the spread of bubonic-plague was associated first with rats, and then with rat-fleas; and at once it became of enormous importance to know which of the numerous species of rat-fleas would attack human beings. The Hon. Charles Rothschild, who has accumulated a most splendid collection of preserved fleas in the museum at Tring, had some years ago differentiated from an undifferentiated assemblage of fleas a species first collected in Egypt, but now known to be the commonest rat-flea in all tropical and subtropical countries. This species, *Xenopsylla cheopis*—and to a lesser extent *Ceratophyllus fasciatus*—unfortunately infests and bites man. If they should have fed upon a plague-infected rat and subsequently bite man, their bites communicate bubonic plague to human beings. Plague—the Old English "Black Death"—is a real peril in our armies now operating in Asia and in certain parts of Africa.

Just as some fleas attack one species of mammal or bird and avoid closely-allied species, so the human flea has its favourites and its aversions. There is a Turkish proverb which says, "An Englishman will burn a bed to catch a flea," and those who suffer severely from flea-bites would certainly do so. The courage of the Turk in facing the flea, and even worse dangers, may be, as the schoolboy wrote, "explained by the fact that a man with more than one wife is more willing to face death than if he had only one." But there are persons even a flea will not bite. Mr. Russell has reminded us, in his preface, of the distinguished lady who remarked, "*Quant à moi ce n'est pas la morsure, c'est la promenade!*"

There are one or two structural features in a flea which are peculiar, the most remarkable being that, unlike most other insects, it is much taller than it is broad. As a rule, insects—such as a cockroach, the bed-bug, or a stag-beetle—are like skates, broader than they are tall; but the flea has a laterally compressed shape, like a mackerel or a herring. Then, again, the three segments or rings which come after the head are not fused into a solid cuirass or thorax as they are in the fly or the bee, but they are movable one on the other. Finally, it is usual in insects for the first joint of the leg to be pressed up against and fused with those segments of the body that bear them; but in the flea, not only is this joint quite free, but the body segment gives off a projection which stretches out to bear the leg. Thus the leg seems, unless carefully studied, to have an extra joint and to be—as, indeed, it is—of unusual length. They certainly possess unusual powers of jumping—as Gascoigne, a sixteenth-century poet (1570–78) writes: "The hungry fleas which frisk so fresh."

The male, as is so often the case amongst the invertebrata, is much smaller than the female. The latter lays at a time from one to five minute, sticky, white eggs, one-fortieth of an inch long by one-sixtieth broad. They are not laid on the host, but in crevices between boards, on the floor, between cracks in the wainscoting, or at the bottom of a dog-kennel or in birds'-nests. Mr. Butler recalls the case of a gentleman who collected on four successive mornings sixty-two, seventy-eight, sixty-seven, and seventy-seven cat-fleas' eggs from the cloth his cat had slept upon. Altogether 284 eggs in four nights. The date of hatching varies very much with the temperature. *Pulex irritans* takes half as long again—six weeks instead of four—to become an adult imago in winter as it does in summer. But in India the dog-flea will complete its cycle in a fortnight.

When it does emerge from the egg the larva is seen to be a whitish segmented little grub without any limbs, but with plenty of bristles, which help it to move about; this it does very actively. There are two small antennæ and a

pair of powerful jaws, for the larva does not take liquid food, but eats any scraps of solid organic matter which it comes across; dead flies and gnats are readily devoured. The larva casts its skin several times, though exactly how often it moults seems still uncertain.

After about twelve days of larval existence it spins itself a little cocoon in some sheltered crevice, and turns into a whitish inert chrysalis or pupa. During its pupal existence it takes, of course, no food, but it grows gradually darker, and after undergoing a tremendous internal change, breaking down its old tissues and building up new ones, the chrysalis-case cracks and the adult flea jumps out into the world.

Perhaps the most important of biting insects is the mosquito, certain species of which convey malaria—a disease which has probably played a bigger part in the history of the world than that conveyed by any other insect. As in most other biting insects, the piercing organ consists of a tube, or gutter, in the hollow of which lie certain chitinous rods, with saw-like edges, and the outer gutter encloses an inner gutter facing the other way, up which ultimately the blood the mosquito sucks will flow. In the mosquito there is also a median structure, like a double-edged sword, the prolongation of the lower lip. This is traversed by the duct, from which flows the so-called saliva of the insect. This saliva carries with it the microscopic, unicellular animals which cause malaria, and down this minute, microscopic duct has flowed the fluid which has altered the fate of continents and played a conspicuous part in destroying the civilisations of Greece and Rome.

The female is very voracious, but the mouth parts of the male are not strong enough to penetrate the human skin; it has to be content with a diet of vegetable juice. Still, the female will suck up blood till all the cracks between its chitinous armour are incarnadined. It is thought by some that no eggs are laid unless a meal of blood has been taken. This, however, does not seem to have been definitely established.

Anopheles maculipenis is the chief carrier of malaria, and is found very widely distributed throughout the world. As a rule, individuals do not wander very far on their own account, but they can be blown considerable distances by a wind, and they have a habit of travelling about in trains and ships, but not, perhaps, to the same extent as *Stegomyia calopus*, which conveys the yellow fever. The female hibernates throughout the winter, and has been found under the frozen snows of Siberia, mingled with the moss and snow. In England they are frequently found in old out-houses, deserted cellars, and unused farm buildings. They have generally left their winter quarters by May, when they begin to lay their eggs, and this they do early in the morning. In temperate climates there are three or four generations during the summer, the latest being through September and October. It has been calculated that if the number of eggs laid by the female be 150, the numbers of the descendants by the fourth generation would amount to over thirty million. This may account for the enormous numbers in which mosquitoes are found in places like Finland, Siberia, and other northern climates.

The eggs are rather like little lifeboats, with a floating ridge on each side which keeps the ova the right way up. They are black with a certain iridescence, and, like all other objects floating on the surface, they tend to form star-like or reticulated patterns, and if they are near where the water touches the edge of the vessel they are drawn a little way up. But the head-end of the egg always points downwards, so that should the larva emerge whilst in this position it at once gets into its proper element. The larva emerges during the second or third day after oviposition, according to the temperature. It is one of the most interesting aquatic larvæ we know. It hangs on the lower surface of the surface-film by a series of palmate hairs; and by its open stigmata, which pierce the surface-film, it puts the interior of the body in connection with the atmosphere. The head is provided on its under surface with two moustache-like structures, which constantly sweep the under surface of the surface-film, sweeping the organic matter which may have floated up there into the larva's mouth. Since the dorsal surface of the larva is uppermost, and the brushes are on the ventral surface of the head, when feeding the head is turned round at an angle of 190°, and this is done with so much precision that you can almost hear it click. The pupa is also attached to the surface-film by its breathing trumpets, and it is these stigmata, or breathing pores, that are the weak point in the structure of these diptera, since it is easy by brushing paraffin through the water to establish a thin surface-film of oil, which cuts both larva and pupa off from the necessary oxygen, and so kills them.

Stegomyia is somewhat different in appearance. It is especially a haunter of the dwellings of man, and it frequents ships. Its egg is covered with a series of reticulations containing air

which enables it to float, and the larvæ, unlike those of *Anopheles*, but like those of *Culex*, hang down into the water by single respiratory stigmata.

They seem to bite all the twenty-four hours round, and although we have not been able to isolate the organisms which cause yellow fever, there is no doubt the fever is conveyed by this species of mosquito.

There are also a number of biting flies, such as the *Tsetse* fly, which sucks blood greedily, and the blood-sucking maggot of a fly, a larva of *Auchmeromyia luteola*, which chiefly affects natives sleeping on mats in Central sub-tropical Africa, and there are, of course, many flies which injure horses and cattle, and materially diminish the value of their hides. Leather plays a very conspicuous part in warfare. The deterioration of hides owing to the warble fly very materially affects the leather market, not to mention the fact that when cattle are attacked the meat is also seriously damaged.

Let us turn now for a few minutes to the insects that affect the food of man. Both the house-fly and the blue-bottle fly act in this manner.

In our country house-flies usually begin to breed in June and July, continuing well on into October if the weather be but warm. Their greatest activity is, however, in the hotter month of August and the beginning of September. But in warm stables, restaurants, and kitchens, flies are able to reproduce the whole year round. A single fly will deposit at one time 100 to 150 eggs, and in the course of her summer life may produce five, or even six, batches of ova of this size. The eggs are pearly white, elongated structures, with two converging lines, along which the egg-case will ultimately split to give exit to the larva. The eggs are laid, by means of a long ovipositor, a little way beneath the surface of the dung-heap in a position where they will not readily be dried up. In favourable conditions the eggs hatch in from eight to twenty-four hours.

The larvæ are legless, tapering towards the head, which bears a pair of breathing-holes, or spiracles; their bodies are much stouter towards the hinder end. On the whole they are white, unpleasant-looking maggots, called by fresh-water fishermen "gentles." By contracting and expanding its body it pushes its way through the moist, semi-liquid surroundings. The skin is usually moulted some twenty-four hours after birth, but all these time-limits depend much upon the temperature and favourable conditions. With normally high temperatures—say, with 86° to 95° F.—the larva will become fully grown in five or six days. The third and final stage, after the second moult or ecdysis, lasts three days, and when fully grown the maggots are about half an inch in length. Externally, twelve segments are visible, but the internal anatomy shows that thirteen are really present, though one is almost "masked."

It is only during these larval stages that the insect grows, and it is never more bulky than in the third larval stage. Now it leaves the moist situation in which it has flourished, and, crawling through the manure, seeks some dry or sheltered corner near the surface of the manure heap. For a time it rests, and then after an hour or two's quiescence it retracts its anterior end and assumes a barrel-shaped outline, its creamy white colour slowly changing to a mahogany brown. The larval skin forms the pupa-case, and within this pupa-case the body of the larva undergoes a wonderful change, far greater than ever human beings undergo at the time of puberty. Many of its organs are disintegrated and re-formed, and in the course of three or four days the white, legless, repellent maggot, who "loves darkness rather than light," is changed into a lively, flying insect, seeking "a place in the sun" and the companionship of man. As the Frenchman said of the pig which goes into one end of the machine in the Chicago meat-factory as live pig and comes out at the other end in the form of sausages, "*Il est diablement changé en route.*"

In a very short time after leaving the pupa-case the adult fly has stretched her wings, the chitin of her body has hardened, and she flies away "on her several occasions."

Flies become sexually mature in a week or ten days after emerging from the chrysalis-case, and are capable of depositing their eggs four days after mating, so that if the conditions be indeed favourable the whole development from the egg to the perfect fly may be accomplished in nine or ten days, and the second generations are able to lay their eggs ten days later. The appalling fecundity of such an insect explains the fact that in the hotter parts of the world nearly every edible thing seems to be covered with flies.

The proboscis of a fly can only suck up liquid food; and when we see it feeding on solid substances, such as sugar, it has really dissolved the sugar by depositing some saliva on it, and is sucking up the sugary solution so produced. It not infrequently regurgitates its food in a spherical drop, which it generally reabsorbs.

As we have seen, flies are very susceptible to temperature, and with the approach of cold weather they seem to die. We used to think that some, in a state of suspended animation, "carried on" through the winter months. This is, however, "non-proven." Many of them undoubtedly die in the autumn, as bees die, of old age. They are literally worn out. But a great number fall victims to a parasitic fungus called *Empusa*. Flies killed by this fungus are frequently to be seen in autumn, hanging dead on windows, etc., surrounded by a little whitish, powdery ring of spores formed by the fungus.

Flies, like many other common insects, are extremely difficult to keep alive in captivity, and few have succeeded in rearing them for more than a month or two. At one time, as we have said, it was thought that those flies which survive the winter were fertilised females of the younger broods, and that during the winter they subsisted on their "fat bodies."

Doubt, however, has recently been thrown on this theory, and at the present time, as the Local Government Board states, the manner in which the interval between one fly season and the next is bridged over still remains unsolved.

Flies breeding in horse manure, or coming direct from infected organic matter, affect the jam, the milk and other food of the soldier. Until the perfecting of the anti-typhus inoculation was effected, in times of war typhoid killed more soldiers than bullets. Infantile diarrhœa is another disease associated with *Musca domestica*, so are ophthalmia and anthrax.

It will be noted that the fly acts simply as an inoculating agent. The germs which are conveyed are mostly bacteria, and they do not necessarily undergo any change in connection with the body of the house-fly.

Next we come to a series of insects which affect the food of soldiers and sailors. One is the flour-moth, *Ephestia kuhniella*, whose larva burrows through the soldiers' biscuit and not only consumes a considerable portion of it, but renders it so unpalatable that Sergeant Daniel Nicol, of the 92nd Gordon Highlanders, tells us that, during the Expedition to Egypt in 1801, "some vessels were despatched to Macri Bay for bullocks, and others to Smyrna and Aleppo for bread, which was furnished us by the Turks—a kind of hard dry husk. We were glad to get this, as we were then put on full rations, and our biscuits were bad and full of worms; many of our men could only eat them in the dark." The biscuits become infected during the cooling which takes place between the baking and the packing. The adult insect, *E. kuhniella*, is a perfect nuisance in flour-mills. So persistent and numerous are these moths at times that they clog the rollers with their cocoons, and sometimes completely stop them. The webbing of the elevators in the mills gets covered with them, and with their silky skeins, and then the elevators stop working. They mat together the flour and meal with their silken excreta, and so uniform is the temperature of the mill, and so favourable to the life of the insect, that they complete their life-cycle in this country in two months, and in the warmer parts of America even more rapidly. In well-heated mills the proceeding is continuous, so that six generations at least may be produced each year.

Now that the war is spreading in the Near East, a word or two should also be said about an allied species of insect, *Ephestia cautella*, which infests at times 50 per cent. of the figs of the East. It is a moth which is spread all over the world, and is catholic in its taste, since it flourishes on rice, bran, dried apples, maize and a great many more or less nutritious foods. It lays its eggs in the figs whilst they are being dried in the sun. From the egg a small maggot emerges and whoever eats dried figs must at times come across them. These larvæ, which emerge towards the end of September or October, render a voyage on a fig-laden ship very unpleasant, as they crawl about the ship before pupating.

Finally, we must not forget the biscuit "weevil," so familiar to us in Marryat's novels. And the first thing to notice about it is that it is not a weevil at all. It is in truth known as *Anobium paniceum*, and is closely allied to *A. striatum*, which makes the little round holes in worm-eaten furniture so cleverly imitated by second-hand furniture dealers. There is hardly anything the larva of this insect will not eat, from cayenne pepper to opium, from tablets of compressed meat to Arabic manuscripts. It is, however, to-day far less common than in the past through the invention of the biscuit-tin, a comparatively modern discovery, which has done much to interfere with its plans.

DISCUSSION.

The Chairman (Sir William J. Collins, K.C.V.O., M.S., F.R.C.S.), in opening the discussion, said he was sure the audience would agree with him that Mr. Howlett had very ably undertaken the delivery and illustration of a lecture for which he was not personally responsible. Although he might not hold identical views in every respect

with the author of the paper, he had informed him (the Chairman) that, as a master of the subject, he was perfectly willing and able to answer any questions that anybody present chose to ask. As he listened to the paper he was reminded of a saying of, he thought, the late Sir William Gull, who once made the observation in his emphatic and rather Napoleonic way, that he always observed that new discoveries came out of the residuum of knowledge. That was true of the subject-matter of the paper. He believed Gull illustrated it from the way in which Professor Charcot, when attached to an infirmary in Paris, drew the most illuminating discoveries out of what was practically the dustbin for the mental and moral rubbish of Paris, and out of that elucidated the studies of the diseases of the nervous system. So, on the present occasion, out of matter that had been despised, neglected, and treated as hardly suitable, and perhaps too indelicate for polite ears and polite conversation, had come some of the most illuminating discoveries in regard to the origin of infectious diseases or the mode of their propagation. It had been said that the ancients attributed epidemics to the interventions of the Infinitely Great. It might be said that the moderns attributed at any rate many epidemic diseases to the operations and machinations of the Infinitely Little. This was the day of the infinitely little: the infinitely little had come into its own. In the case of plague, typhus fever, malaria, yellow fever, and perhaps blackwater fever, there was a good amount of evidence accumulating to show that the parasitic arthropods were instrumental in propagating those diseases. Much of what the ancients regarded as the mystery of infection, and attributed vaguely to the epidemic constitution of the air, or to obscure telluric conditions, if not to the interventions of providence, was shown to be due to a process of inoculation by some of the minute members of the insect family. It was said proverbially that the law cared not about minimal things. It had been reserved for the medical man and the pathologist to regard them, and to realise that—

"Great fleas have little fleas
Upon their backs to bite them,
And little fleas have lesser fleas,
And so *ad infinitum*."

Mr. Howlett had alluded to a case in India in which he had seen a remarkable collection of bugs *en masse*. He (the Chairman) would give an example nearer home. When he was attached to the resident staff of St. Bartholomew's Hospital some twenty-five years ago, and had to go into the purlieus of Cloth Fair and Central Street, St. Luke's, and thereabouts, he had seen quite as ample conglomerations of the active bug in some of the mean streets which, happily, had been largely swept away by the operations of the London County Council. As evidence of the difficulty of getting rid of the bug when once it had taken up its residence, he could recall when he was on the Housing Committee of the County Council, the extreme difficulty experienced in a certain doss-house not far from Drury Lane, in often getting rid of the bugs from the interior of the iron tubes of which the bedsteads were made. Apparently nothing short of actually exposing the iron to a high temperature was successful in getting rid of them. He was sure the members were greatly indebted to the learned author, whose absence they so greatly deplored, and also to Mr. Howlett, for having devoted so much of their lives to such an interesting, but, perhaps, in the minds of some people, such a repulsive topic. They had made themselves the familiar and the associate of the creeping and crawling things. They had not hesitated to make experiments *in corpore vili*. The public rejoiced in their results and discoveries, and could not help tendering to them their gratitude for the self-sacrifice which they had imposed upon themselves. It might be said of them that, like Prometheus, they had stolen the sacred fire from Heaven, and with it had illumined and animated the very dust, the filth, and the vermin of the earth.

Mr. G. Hurlstone Hardy suggested that the paper should be followed by another one dealing with the question of the cure for the complaints for which the insects were responsible. Dr. Ross's paper read before the Society last year was confined entirely to the fly, and it was followed by some most interesting correspondence. He began to study the subject of flies more than fifty years ago, and knew from his experience that a great deal of misunderstanding existed about them. He had been struck very forcibly, in listening to the paper, with the tenderness and delicacy of the body-louse, how readily it died, and yet it multiplied in enormous numbers. The same remark applied to the house fly. It was an artificial product which differed entirely from all the three thousand British flies, nearly one hundred of which were commonly mistaken for house flies, in that it sought the abode of man. It possessed peculiar habits, and it was only when they were fully understood and realised that a cure would be obtained. Little palliatives like fly-traps and very ineffective poisons were useless. After studying all the American reports he had come to the conclusion that much of the advice given was very often radically wrong; it was well intended, but was not correct entomologically. But there were great hopes, which rested largely upon the peculiar, delicate nature of the fly, which he suggested would form a good subject for a special paper. He had come to the conclusion that the cure for flies lay in the cremation of domestic rubbish.

Lieutenant K. B. Williamson said that he personally, and many others who were going to the scene of operations, would be only too glad if any details could be given by the author of the

newer method of dealing with the fly plague which he understood had been recently produced both at Cambridge and by Professor Lefroy, who recently lectured on the subject before the Zoological Society. He believed it was in the form of a spray, and it was said to be remarkably effective on the adult insect. He also heard, when he was at Cambridge, although he could not obtain any details, that another specific had recently been introduced by Dr. Graham Smith in collaboration with Dr. Warburton.

Mr. F. M. Howlett, in reply, said that he was entirely at one with the remarks that had been made by the first speaker. The delicacy of the adjustments, not only of lice but of house flies, to special conditions was a subject which it was impossible to avoid introducing if any work on it was done at all. At the same time, he did not think at present their knowledge was sufficiently deep. A good deal was known about the conditions in a superficial way, but enough was not known about their deeper physiology to enable them to say that they must adopt methods based on the adaptation of conditions against the fly rather than crude common-sense everyday methods such as sprays and the like. He had personally a great bias towards the adoption of anti-insect methods generally which were based upon a knowledge of their dependence upon particular conditions. A method had now been adopted which was based on a recommendation of his own for dealing with house flies by paying attention to one particular point in their life history, namely, that, when the house-fly maggot wished to turn to a pupa, to a chrysalis, it had to rid its body, somehow or other, of a certain amount of water to enable it to dry up sufficiently to form a proper pupa case. If it was living in a damp place, such as a manure heap, as it generally was, when it wanted to pupate it went outside the manure heap, or into its driest portions, before it did so. That method, which it was claimed had had good results in America, and had also been adopted at the front to a certain extent, simply consisted in keeping the manure damp, but arranging that within easy reach there should be dry places into which the maggots could go when they wanted to pupate, and which were so arranged that they could easily be destroyed by fire or otherwise when they got there. As to the cremation of domestic rubbish being the cure for fly-infestation, he thought the best thing he could do was to offer an invitation to Mr. Hardy to attend one of the lectures which he periodically gave to the London Sanitary Corps, in which he went as thoroughly as he could, in the course of an hour, into the actual practical methods adopted at the front and recommended at home for dealing with flies. The incineration of rubbish of all kinds was at present carried out wherever possible at the front, but the difficulty existed that that could not very often be done, either because there was no incinerator, or because such vast quantities of manure were being dealt with that it was beyond the capacity of the incinerators to cope with them. There was no doubt at all that it was an absolutely first-class thing to do. He also touched on, in the lecture to which he referred, the newer methods mentioned by Lieutenant Williamson. He recently went to Cambridge to see Dr. Graham Smith on the subject, and that gentleman appeared to have discovered something which was very good indeed as a deterrent to blow-flies—not house flies particularly—and as a general antiseptic of extraordinary power. He was shown a piece of a dead horse which had been left out in a field either for a fortnight or three weeks; it was not the least bad, and apparently no fly would lay any eggs on a piece of flesh that was treated with the stuff. He was not at liberty to say what the stuff was, but he would be only too glad to give any further details if possible. He (Mr. Howlett) could claim to be the inventor of the spraying method, and naturally he thought it was very good. The object kept in view was to make a spray which would clear hospitals and places of that sort, and it was found that by taking ordinary pyrethrum and treating it with alcohol a solution was obtained which, if it touched a fly, would paralyse it for some hours, but would not kill it. Within five minutes of spraying the flies fell down all over the room in a most gratifying way, but it was necessary to go round with a brush and sweep them up if it was desired thoroughly to clear them out. Ultimately he discovered a substance to add to the solution which not only completely paralysed them but killed them. He was afraid he could not tell the members what it was, but he could tell them where to get it; and he believed it was now being used at the front. He gave periodically a lecture to batches of about fifty men of the London Sanitary Corps before they went to the front. It was of a purely practical nature; it did not deal with scientific entomology or anything of that sort, but it answered the requirements which the speaker indicated. If any of the members cared to attend the lecture, and would furnish the Secretary of the Society with their names, they would receive a notification when the next lecture would be delivered.

On the motion of the Chairman a very hearty vote of thanks was accorded to the Master of Christ's College for his able lecture, and to Mr. Howlett for his admirable exposition thereof, and the meeting terminated.

GLASS IN INDIA.

The Quinquennial Review of the Mineral Production of India contains some information as to the occurrence of glass-making materials, which is of special interest in view of the efforts now being made to encourage the manufacture of glass in India.

There is no difficulty in obtaining the material for the inferior varieties of glass used for bangles, etc., as the common impure sands of the rivers and the efflorescent alkali salt abound in many parts of India. The chief obstacle to the manufacture of the better grades of glass is the absence of known deposits of quartz-sand of the requisite purity and of suitable texture. In a few places, however, attempts are being made to introduce European methods, and to make a better class of article. The factory at Rajpur, near Dehra Dun, known as the Himalaya Glassworks, which started in 1903, and seemed at one time on the road to success, has been closed down. In an interesting Blue-book published this year, Mr. F. O. Oertel describes a visit to glassworks in England, Austria, and Germany, analyses the causes of failure at Rajpur, and advances suggestions for the guidance of future enterprises of a similar nature. He especially advocates the manufacture of *churi*, or bangle glass.

No less than three other glassworks have been started under Indian management—viz., the Paisa Fund Glassworks at Talegaon, Poona district, Bombay, in 1908; the Upper India Glassworks at Ambala in 1914; and the Jubbulpore Glass Factory. The sand for the Talegaon works is obtained by crushing quartz found locally, and the lime is obtained from Bombay. The sand and lime for the Ambala works are obtained from Dehra Dun; for the Jubbulpore works the sand is local, and the lime obtained from Katni. The soda is imported in each case. These factories devote themselves principally to the manufacture of lamp globes and chimneys, bottles and tumblers; but other articles are also produced, especially at Talegaon.

The sands found at various localities in the Rajmahal Hills, and reported to be suitable for glass-making, have been investigated by Mr. Murray Stuart. He considers that they are generally unsuitable for the manufacture of any but the commonest kinds of bottles. The sands considered occur as (1) recent river-sands, and (2) Damuda (Gondwana) sandstone.

To what extent a glass-making industry would find a market in India may be judged by the fact that during the past fifteen years the annual imports of glass and glassware have gradually risen in value from £440,000 to over £1,300,000 in 1913, the average value for the period being £1,057,788. The chief items in this total are bangles, beads, and false pearls, common bottles, lampware, sheet and plate glass.

THE REELING OF TUSSAR SILK.

Tussar silk is more difficult to reel from the cocoons than mulberry silk, and the cocoons must be boiled in an alkaline liquid preparatory to this operation. The natives add the ashes of plantain leaves to water and boil the cocoons in this for two or three hours, and then leave them to ferment for some hours before winding. In some factories in Bengal the cocoons with their stems cut off are tied up loosely in a cloth; this is weighted down with stones and boiled for half an hour in a solution containing three parts of potassium carbonate dissolved in eighty parts of water, oil and sugar being sometimes added. The cocoons are afterwards boiled for a few minutes in water containing a little glycerine. The silk is then reeled in the same way as mulberry silk. The glycerine keeps the cocoons moist while reeling, and it is not then necessary to keep them in basins of water during this operation. Another method is to prepare a fine powder or paste from the chrysalides of tussar or mulberry insects; about one part by weight of this is mixed with two parts by weight of dry cocoons and the mixture is tied up in a cloth, weighted, and immersed in water, which is then boiled for an hour. The mixture is next left to ferment for twelve hours, after which reeling begins, the cocoons being allowed to rotate in basins of hot water just as when mulberry cocoons are reeled.

The reeled silk obtained by any of the above processes must next be immersed in a warm acid solution, then washed in a bath of boiling soap or washing soda solution, and finally rinsed in boiling water, wrung, dried, and baled for export. The object of the acid bath is to neutralise the lime and alkali, which would lessen the brilliancy and elasticity of the fibre; it can be prepared from tamarinds, using one part by weight of tamarinds in water to every four parts by weight of tussar thread. The tamarinds are washed and mixed with water, and the liquid is strained through a cloth. The treatment with soap or washing soda can be omitted, but the final rinsing with boiling water must be done. One man can reel about 260 tussar cocoons in a day, obtaining 18 to 20 tolas (about half a pound) of silk.

It is stated that one difficulty in reeling tussar silk is to make the separate strands cohere in the reeled thread; in the case of mulberry silk the cement is only softened in the reeling basin, and hardens again, gluing the strands together.—*Bulletin of the Imperial Institute.*

DEVICE FOR COMPUTING VALUES OF TUNGSTEN LAMPS.

It is well known that a change in the voltage applied to the terminals of an incandescent lamp changes the candle-power, current, and, in consequence, the wattage (watts = volts × amperes) and the watts per candle. If these changes are followed from point to point, relations among the variables may be found and plotted as characteristic curves. The equations of these characteristic curves for tungsten lamps have been found by the Bureau of Standards of the United States Department of Commerce, and a special application of these equations has been made in a device which gives a

solution of problems involving voltage, candle-power, and watts per candle.

In this device the volt scale is movable, and, by setting it to the other scales at a point corresponding to the observed watts per candle, values of per cent. candle-power and of actual watts per candle may be read directly from the proper scales, or the converse problems may be solved. Use of this device results in a decided saving of time when compared with other methods of characteristic evaluation. In connection with the device are given tables of values used in its construction and practical examples illustrating scale settings.

Copies of the report upon this subject may be obtained upon application to the Bureau of Standards, Washington, D.C.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Indispensable Men.—It has been announced that the official List D, consisting of men engaged in occupations of cardinal importance and "starred" for recruiting purposes, is open to subsequent revision. In order to meet the ideas of textile employers the revision must needs be extensive. The list omits the names of many callings which have the same right to inclusion as any that appear, and it takes no account of others whose position is incontestably more critical. It is inconsistent at least to forget the linen and jute trade entirely, while remembering the cotton, woollen, worsted, and silk industries. Then a list is manifestly incomplete which provides for the case of the workman but not for that of his manager. These major inconsistencies leap to the eyes, and on a closer examination the selection of grades of workpeople is seen to bristle with smaller ones. Manufacturers would be left with warps apparently, and with female weavers, but without men for warp-dressing and twisting-in, and without foremen dyers to dye the goods when made. There seems to be more to hope from a consideration of individual cases upon their merits, than from any attempt to lay down unyielding rules.

Curious Trade-names.—Trade names offer a rich quarry to the lover of the curious, and every long list of them brings unfamiliar names to light. The schedule of starred trades presents a few, including that of the "taper" in the cotton mill. The slightly derogatory flavour attaching to such a name is imperceptible in Lancashire, where a taper is a man of consequence. He has no connection with cotton tape of the ordinary variety, although a tape-like appearance is assumed by the parallel warp-threads that it is his business to treat. A taper is a sizer whose machine applies mucilaginous matter to the warp to facilitate its weaving. The sizing must neither be too strong nor too weak if the weaver is to be spared fruitless trouble, and in this matter experience is the great guide. The machine at which he works is normally of the type called "slasher," and for greater security the official list names sizers thrice, first as sizers, second as slashers, and third as tapers. The "openers" of the cotton trade are in charge of the opening machines for cleaning and disentangling matted fibre, and the "scutchers" have a not dissimilar duty. The "overlooker" whose business lies with machines and operatives, is a functionary distinct from the "lookers-over" who practise a cultivated rapidity in noticing anything that is amiss with woven cloth. A "tackler" is a weaving overlooker and is the Lancashire equivalent of the Yorkshire "tuner." The "grinder" in a preparing or spinning mill, grinds to uniform length the wire teeth of the rollers and cylinders of the carding machines. "Fettlers" in the woollen trade perform other work in making ready the carding-engines, and when a fettler works in the worsted trade his name is "jobber." Among quaintly-named trades not mentioned in the list in point may be included the "slubber," who is concerned with light, loose, barely-twisted ropes of prepared fibre, and the "crabber," who crabs the shrinking and cockling tendencies inherent in undyed worsted cloth. The dyehouse has its "box-watchers," who have the function of watching patent dyeing machines, and its "top-siders" and "low-siders," who share between them an unequal responsibility for the due guiding and working of the cloth.

Sample Exhibition.—Manufacturers in various parts of the country have refreshed their acquaintance with German goods by examination of the samples exhibited successively in different centres by the Board of Trade. Any one manufacturer is directly interested in what is only a very small part of most of these aggregations of mixed samples, and the picking-up of valuable ideas, other than general ones, must remain much a matter of chance. It appears that some visitors have discovered suggestive trifles, and have carried away ideas to be elaborated later. In the ordinary way, the practical man is more interested in an idea to turn to immediate account than in revolutionary methods, and he is not ungrateful for inspiration wherever found. A small cutting of cloth, embodying some feature which can be expanded without being actually imitated, is valued, although perhaps for reasons distantly removed from the capture of any specifically German branch of trade. In that manner a wholly fortuitous collection of miscellanies may be capable of use, and such sample exhibitions as have been seen hitherto have worn the unmistakable air of chance, not of orderly selection and rejection.

Some German Goods.—The uninstructed public wandering through the exhibition rooms displays an indiscriminate awe and wonder at "what we have to beat," with never a suspicion that the exhibits include goods in which the Englishman has the German beaten handsomely from the beginning. It can be said with some emphasis

that there are no livings to be made in England by producing such woollens and worsteds as were displayed in the recent exhibition at Leeds. The goods were of altogether undistinguished style, and with few exceptions represented lamentable value for money. So far from being examples to emulate they were gratuitous instances of what to avoid, and they were not the only types of which it could be predicated, with entire conviction, that not much could be sold. The presence of such goods cheek-by-jowl with some more deserving of attention is not all to the advantage of these exhibitions, and in this matter there is room for discrimination. Presumably in time to come greater effort will be exerted to make the home market, at any rate, more self-supporting in the supply of wool plushes for slippers and upholstery. The yarns and looms used being mainly English, it would not seem out of the question to weave them here, and also to produce such waste-cotton tapestries as are employed as cheap cushion-squares. Some wool cashmere dress-stuff patterns, all the way from Fiji, are rather of French than English interest, as France is in possession of the requisite types of machinery. An effective reason why the production of certain calico prints and other coloured goods will not be attempted at present in England lies in the absence of dyestuffs.

Clothes and the Sun.—A report upon sanitation in India has been briefly quoted in the English press, relating that there is no foundation for the belief that a red lining to helmets reduces the temperature of the air between helmet and scalp. It may be doubted, however, whether reduction of temperature is the objective of the helmet maker, any more than it is of the khaki-drill manufacturer who reddens his fabrics on the obverse. Drills are sometimes dyed red upon one side only by means of the pad-dyeing machine, or are woven with a red weft which is concealed upon the face by the brown threads of the warp. In either event, the theory is that the red lining acting as a light-filter, cuts off the actinic rays of the sun in the same way as the red glass in the photographic dark-room light. The actinic rays in turn are understood to be those most provocative of prickly discomforts to the skin. Red is not credited with great virtues of heat-absorbency, and if it were the place for it would plainly be the surface upon which the rays strike. The outside of the helmet or garment might be red-coloured, were it seriously supposed that a red surface afforded more protection than the obviously cooler yellow, or the still cooler white.

Japanese Competition.—Reports tell of a new activity in Japanese competition in the cotton trade. Both in Bombay and in Manchester patterns have been shown of finer makes than have come from Japan hitherto, and in India a considerable amount of business has been booked. Skill has been shown in duplicating standard Bombay drills and satins, and Lancashire shirtings and dhootie cloths. Some of the prices named give the Japanese offer an appearance of extraordinary cheapness. Except in cases of desperate need established makes could hardly be quoted so much below the market, and the inference is that the producers are uncommonly eager to break into the new fields. Generally, Japanese textile workmanship is found less thorough and consistent than English, and the effect is of course to make the goods worth less in the eyes of the buyer than those which can be relied on implicitly. Time must be left to pronounce upon the quality of Japanese deliveries, but the forward step in attempting these more advanced articles cannot be ignored. Some circumstances of freight and exchange are exceptionally favourable to Japan at the present, and doubtless the most is being made of these.

The Boom in Hosiery.—The British hosiery industry will come out of the war a much larger one than in 1914. Extension goes on in apparently all the towns and villages in which hosiery is manufactured, and the development is perhaps nothing to wonder at. The great source of imported knitted goods has been cut off, and at the same time the consumption of knitted garments has been enormously increased by the two winter campaigns. To an astonishing extent the demand has been for goods of a high quality, and the consumption of the hosiery trade has great responsibility for the present price of wool. The present prosperity does not quell doubts of what is to happen later when the military demand ceases and the civilian consumers begin to look afresh for cheap undergarments at the prices hitherto paid for the mock woollen clothing imported from Germany. Certainly a great number of people must now be wearing wool where they formerly wore cotton-waste, garnished with labels declaring it "Natural" and "Unshrinkable"—echoes of the descriptive epithets applied to wool. Having made one change they are hardly likely to go back to precisely the same kind of goods as before, and henceforth British manufacturers with their enlarged plants will be less inclined to allow the Saxon and the Wurtemberger to take the business. The time has not come as yet, however, to discuss the making of cheaper stuff. Meantime, the shop windows and the lists of apparel supplied to the army are eloquent of the development of the knitting trade.

OBITUARY.

Sir Michael Barker Nairn, Bt.—Sir Michael Barker Nairn, of Rankeilour, who had been a member of the Royal Society of Arts since 1866, died from heart failure while motoring to his office at Kirkcaldy on November 24th. He was born in 1838, the eldest son of Mr. Michael Nairn, founder of the floorcloth industry in Scotland, and was

chairman of Michael Nairn & Co., Ltd., linoleum manufacturers, of Kirkcaldy, with branches in France, America, and elsewhere. In 1900 he contested Kirkcaldy Burghs unsuccessfully in the Unionist interest. He took a deep interest in education. For many years he was chairman of the Kirkcaldy School Board; he presented a high school and a hospital to his native town, and endowed some bursaries for university students. He was created a baronet in 1904.

MATTHEW HAMILTON GRAY. — Mr. Matthew Hamilton Gray died on September 2nd. He, like his father and three of his brothers, was a life member of the Society, which he joined in 1898. His elder brother Robert, who was a member of nearly ten years longer standing, took a very active part in the work of the Society, but Mr. Matthew Gray never associated himself very prominently in the proceedings of the societies with which he was connected, though, like his brother, he was greatly liked by a large circle of friends, and was also, like him, constantly active in good works of a private nature.

He was born in 1854 at Glasgow, and started in life as a mining engineer. After a few years' experience in America, Borneo, and China, he joined his father and his elder brothers in the service of the India-rubber, Gutta-percha, and Telegraph Works Company of Silvertown. His work with the company was all, or nearly all, connected with cable-laying; and he acted as engineer-in-charge of most of the cable-laying operations of the company.

NOTES ON BOOKS.

THOMAS GAINSBOROUGH. By William T. Whitley. London: Smith, Elder & Co. 1915.

When the Society of Arts was founded in 1754 Gainsborough was already established as an artist, and was working at Sudbury in Suffolk. His student days were therefore over, and he was unable to profit by the encouragement given to many who were almost his contemporaries by the Society's Prizes. He studied in London for about five years, having been sent up by his father when he was thirteen years old, about the year 1740. Part of his art education he may have obtained at the St. Martin's Lane Academy, which was founded by Hogarth some six years before Gainsborough's arrival in London. That this was the case has been stated by some of his previous biographers, but Mr. Whitley thinks that he never was at the academy, because his name does not appear in a list of old students given by W. H. Pyne in his curious publication, "Wine and Walnuts."

Pyne says that he was assisted in the preparation of this list by John Taylor the artist. Now Mr. Whitley argues that as Taylor knew Gainsborough well, and as Pyne was a great admirer of his, and collected a great deal of gossip about him, it is unlikely that they should both have forgotten so important a name. But the list must have been compiled a long time after Gainsborough was dead and when Taylor was a very old man, and lists compiled under these circumstances are not likely to be very complete. The matter, therefore, must be left in obscurity.

Nor was Gainsborough one of the artists who contributed to the first of all picture exhibitions held in London, which was organised by the Society of Arts in 1760, though he did send a picture to the 1761 exhibition which was held in Spring Gardens by the Society of Artists of Great Britain. This second exhibition was, to a large extent, carried out by Francis Hayman, at whose suggestion it was that the Society had held an exhibition in the previous year at its house opposite Beaufort Buildings. It was under Hayman that Gainsborough had studied while in London, and it was at Hayman's suggestion that he contributed to the Spring Gardens exhibition.

The only connection which Gainsborough had with the Society was when he painted the picture of Viscount Folkestone, the Society's first president, for the Society. A full account of the circumstances connected with the painting of this picture is given by Mr. Whitley. The Society was anxious to obtain a companion portrait for the one of Lord Romney, its second president, which had been painted by Sir Joshua Reynolds, and as at the time (1774) Lord Folkestone was dead, an application was made to his son, who had become the Earl of Radnor, asking him to lend the three-quarter length portrait of his father which Hudson had painted in 1749, in order that from it a portrait might be made for the Society. Lord Radnor having consented, it was necessary to find an artist, and at first arrangements were made with Nathaniel Dance to paint an enlarged and altered version of Hudson's work—"a whole-length portrait drawn in the proper Coronation robes, and the same size as the portrait of Lord Romney." For some reason or other, illness and pressure of work being made the excuse, Dance never even began the work, and finally declined. As Mr. Whitley remarks, he throughout appears to have treated the Society with discourtesy. At all events, however this may be, the old minutes show that he seems to have been rather careless in the way he treated the commission, and to have been the cause of not a little trouble and annoyance.

However, the matter was promptly and more satisfactorily settled by Gainsborough's ready assent to a suggestion which came from Lord Radnor himself, that he should be employed for the purpose, and the result was that the Society possesses a portrait of far more interest and value than anything which Dance could have produced. Gainsborough did the work in the most satisfactory manner, and the Society showed its appreciation not only by telling him that they were highly satisfied with his masterly performance, but by the liberal manner in which they dealt with the matter of payment, for it was not

until after the picture had been finished that the artist was asked to mention the remuneration which he expected. Gainsborough then said that his usual fee for a work of this sort was 100 guineas, and this, which was double the sum Dance was to have received, was paid without demur.

There have been so many lives or accounts of Gainsborough that it might have been thought there was hardly room for another. But Mr. Whitley, by his diligent and painstaking research, has added a good deal to our knowledge of the artist, and in many minute details has corrected statements of his predecessors. Much of his new information is derived from the numerous references to Gainsborough by his friend the Rev. Henry Bate, afterwards Sir Henry Bate Dudley, well known as the "fighting parson," one of the founders of the *Morning Post*, and afterwards proprietor of the *Morning Herald*. Mr. Bate, as he was at the time, was a fervent admirer of the painter, and "in the *Morning Herald* he chronicled the progress of Gainsborough's pictures, and supported him against the Academy and against everyone who dare to question his artistic supremacy."

Dudley received two prizes from the Society—a Silver Medal in 1787, and a Gold Medal in 1801—for reclaiming land from the sea. The land was part of the glebe belonging to the parish of Bradwell in Essex, the advowson of which he had purchased. When he abandoned journalism to resume his clerical functions, he presented himself to the living, but was not allowed to occupy it, as he was accused of simony.

Another source upon which Mr. Whitley has drawn is provided by contemporary local newspapers. He has even gone so far as to study their advertisement pages, and from them he has managed to discover the precise dates, previously unknown, of many of Gainsborough's movements. For instance, while he has not been able to satisfy himself as to the exact house in The Circus at Bath inhabited by Gainsborough, he appears to have produced conclusive evidence that it is not the one numbered 24 upon which the Corporation of Bath some time ago erected a tablet. The Royal Society of Arts, mindful of the mistake about the Franklin Tablet in Craven Street, Strand, may sympathise with the Corporation, having had a like experience of the difficulty of precise identification of eighteenth-century dwellings.

Some interesting details are given about the house in Pall Mall, on which the Society placed a tablet to Gainsborough about 1883, though it does not appear that Mr. Whitley realises that further demolitions in Pall Mall have taken place since he wrote his account. Though the part of Schomberg House which formed Gainsborough's dwelling is still intact, what was originally the central portion, and was for long the War Office, was pulled down some years ago, and its site is at the present time occupied by the imposing building of the Automobile Club.

It may be worth mentioning that the exhibition to which, as Mr. Whitley says, Sandby contributed his picture of Lord Harcourt's house in 1760, was the parent exhibition of the Society of Arts, which was not one of the series held by the Society of Artists. The Society of Artists called their first independent exhibition in 1761 the second exhibition, and this it certainly was in a sense, but it was not the second held by the artists themselves.

METALS AND METAL-WORKING IN OLD JAPAN. By Professor William Gowland, A.R.S.M., F.R.S., F.I.C., F.S.A.

The paper which Professor Gowland read before the Japan Society last March has now been reprinted in pamphlet form. Running as it does to nearly one hundred pages, it forms perhaps the most valuable contribution to the subject that has yet been published. The author possesses a fourfold qualification for this task: he is not only one of our first metallurgists; he is also a devoted archæologist and a lover of art, and he spent some sixteen years in Japan as chemist, assayer, and foreign head of the Imperial Japanese Mint.

The pamphlet includes most of the material of the valuable paper on "The Art of Casting Bronze in Japan," which was read by the author before the Applied Art Section of the Society in 1895; but, of course, it covers a great deal more ground, for it treats of all the principal metals over a period of upwards of 2,000 years. It starts with the bronze age, which dates back to some seven or eight centuries before the Christian era, when the Japanese appear to have migrated from the continent of Asia to the islands they now occupy. The aborigines apparently had no knowledge of the use of metals. The earliest examples of Japanese metalwork are two-edged bronze weapons, and Professor Gowland's first illustration is of a stone mould for casting bronze halberds.

A very interesting account, with a curious illustration, is given of the early Japanese method of extracting gold. The metal was obtained by a series of simple washing processes, which seem to have been conducted with much skill. "At the present day some is still similarly obtained, and often from sands containing such small quantities that the Western processes fail to compete successfully with the primitive methods of the Japanese gold-washers.

"The old gold-washers seemed to have received no wages: sufficient gold dust adhered to their garments; and it is naïvely added that sometimes even a nugget became accidentally attached, and this was sufficient to recompense them for their labours."

A special word of praise must be given to the illustrations, which have been selected and reproduced with great care. Particularly interesting is Figure 11, which represents Chinese smiths forging an anchor, and shows how heavy operations were conducted when cranes and similar mechanical appliances were unknown; and particularly beautiful is the figure facing it of the wrought-iron eagle, the original of which is to be seen in the Victoria and Albert Museum.

GENERAL NOTES.

TRADE OF PORT OF NEW YORK AND THE WAR IN EUROPE.—A French journal gives the following figures, showing in francs the value of the exports from the port of New York during the first thirteen months of war, as compared with those of similar period of the previous year:—

	Aug. 1st, 1914, to Sept. 30th, 1915. Francs.	Aug. 1st, 1913, to Sept. 30th, 1914. Francs.
England . . .	2,020,401,555	1,054,564,600
Belgium . . .	3,673,700	146,216,155
France . . .	1,265,291,040	357,521,385
Italy	420,612,580	172,367,270
Russia . . .	180,942,180	109,469,260
Germany . .	29,010,340	453,600,745
Austria-Hungary	177,345	75,349,520
Denmark . .	225,611,070	33,654,070
Spain	30,414,895	38,859,335
Greece . . .	85,671,800	51,830,580
Holland . . .	405,045,610	343,116,045
Norway	110,869,440	34,704,010
Sweden . . .	184,983,600	31,971,200
	4,962,705,185	2,897,224,175

This shows an increase in the value of the shipment of 2,065,481,010 francs during the war.

BOOKS FOR BRITISH PRISONERS AT RUHLEBEN.—The Board of Education have issued a further appeal for books of an educational character for the British civilian prisoners of war (of whom there are some 4,000) now interned at Ruhleben, in Germany. Under the auspices of a Camp Education Department a school and a science and art union have been organised among the prisoners, and in them are enrolled 1,500 students, with 150 lecturers and teachers. The educational work is divided into nine sections, and covers languages, art, science—in fact, nearly all the usual subjects of a school or college curriculum. Persons willing to contribute either books or money may obtain a circular, giving full information on the subject, by addressing a post-card to Mr. Alfred T. Davies, Board of Education, Whitehall, S.W., who is in charge of the arrangements for obtaining and forwarding the books to Ruhleben.

INDUSTRIES IN WEST CHINA.—According to a recent official report, the district of Tzeliuching, which lies in the south-central part of Szechuan, some fifty miles north of Suifu, is the most important industrial centre in West China. This is true not only as regards its present state of development, but also as regards its potentialities and possibilities. Tzeliuching at no distant date will place larger orders for foreign machinery than any other city in this part of China. Machines for drilling new wells, for pumping up the brine, and for evaporating the salt are of first importance. Simple hoisting engines to supplant the water buffaloes should enjoy a large sale. Gas stoves and burners and engines using gas for fuel could also be introduced. As the salt wells are operated night and day, there is an excellent opportunity for the sale of electric-lighting plants. Telephone apparatus is also in demand, and mine pumps and machinery are needed in the coal-fields. There is almost no limit, in fact, to the potential demand; there are, however, many obstacles in the way of meeting it. The vested interests of both labour and capital make it hard to introduce new methods here; a sudden change in this regard would throw hundreds of thousands out of employment. The importance of having a personal representative on the ground cannot be too strongly emphasised. It is utterly impossible to obtain the enormous business at Tzeliuching merely by means of letters and catalogues. An agency placed with some company that carries competing lines is of very little value.—*London and China Telegraph.*

PRACTICAL INSTRUCTION TO MUNITION WORKERS AT MILAN.—A special course of instruction for turners engaged in the manufacture of munitions has been lately opened at one of the principal industrial schools at Milan (Istituto industriale Giacomo Feltrinelli). This institute was established some years ago for the practical and theoretical instruction of mechanics and workers engaged in the metal trades, and for the purpose of encouraging national industry. The number of pupils is limited to the number of lathes at the disposal of the institute. It is, however, a step in the right direction.

KAPOK OIL USED FOR INDUSTRIAL PURPOSES.—Kapok oil is used in the district around Marseilles exclusively for industrial purposes, chiefly soap-making. The residue, or oil-cake, is employed as a fertiliser. The quantity of kapok seed imported into Marseilles cannot be ascertained from the customs statistics, as this product is not separately classified; but according to local brokers it averaged during the last five years about 1,500 metric tons. India is the principal country of origin. The seed is treated in two mills, both of which are, however, chiefly devoted to the crushing of other seeds. According to a report by the United States Consul-General at Marseilles, the seed goes through the same process as cotton-seed and peanuts. Only one pressing is the rule, although in some cases hot water is poured over the residue, which is then pressed again. The oil is then filtered, but it requires neither bleaching, deodorising, nor any other treatment. In the Marseilles mills the average yield in oil from this seed is about 15 per cent. On June 5th last the ruling prices were 70 to 75 francs per 100 kilogrammes (28*s.* 6*d.* to 30*s.* 6*d.* per cwt. about) for oil, and 7 francs per 100 kilogrammes (2*s.* 10*d.* per cwt.) for cake, but the latter is an abnormally low price, resulting from the French Government's embargo on oil-cake shipments. The price of the oil follows closely that of industrial peanut oil. It

takes about 16½ lb. of kapok oil to make a gallon. The density of the oil is 0·9237 at 15° C.; in other words, it is about the same as cotton oil.

THE TRADE OF ASSAM.—According to a report on the trade between Assam and the adjoining foreign tribes and countries, the value of imports during the year 1914-15 was Rs. 19,63,396 against Rs. 18,72,865 in the previous year, the increase being Rs. 90,531, or 4·8 per cent. The increase occurred chiefly under the head of animals, dyeing materials, hides and skins, musk, spices, and blankets. The total exports amounted to Rs. 16,46,659, representing an increase of Rs. 31,710, the greater part of which occurred under metals, silk, and betelnut. About 96 per cent. of the total trans-frontier trade is carried on with Bhutan, and the value of the import trade with this country rose by Rs. 89,040. The offer of higher prices for ponies, and the larger demand for horned cattle in the previous year, apparently stimulated the Bhutias to visit the plains in larger numbers. The principal articles of imports were ponies (Rs. 1,11,033), horned cattle (Rs. 43,932), oranges, hides and skins, lac, musk, ghee, spices, wax, and woollen goods.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.

DECEMBER 8.—LIEUT.-COLONEL W. A. TILNEY, F.R.G.S., F.R.A.S., late 17th Lancers, "The Art of Finding your Way at Night without a Compass." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

DECEMBER 15.—J. JEF. DENYN, Carillonneur de Malines, and WILLIAM W. STARMER, F.R.A.M., "Carillons and Carillon Playing." W. G. MCNAUGHT, Mus.Doc., will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

DECEMBER 16.—C. C. MCLEOD, President of the London Jute Association, "The Indian Jute Industry." SIR JOHN PRESCOTT HEWETT, G.C.S.I., C.I.E., will preside.

Papers to be read after Christmas:—

PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

R. W. SETON-WATSON, D.Litt., "The Balkan Problem."

CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

LAWRENCE CHUBB, "The Common Lands of London: the Story of their Preservation."

THE HON. LADY PARSONS, "Women's Work during and after the War."

REV. P. H. DITCHFIELD, "The England of Shakespeare."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

VICTOR HORTA, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

CHARLES DELCHEVALERIE, "Belgian Literature."

LESLIE URQUHART, "The Economic Development of Russia."

J. ARTHUR HUTTON, Chairman of the British Cotton Growing Association, "The Effect of the War on Cotton Growing in the British Empire."

S. CHARLES PHILLIPS, M.S.C.I., "Paper Supplies as affected by the War."

PROFESSOR T. G. MASARYK, "The Slavonic Peoples."

COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., late Survey of India, "The Romance of the Indian Ordnance Survey."

C. A. KINCAID, C.V.O., Indian Civil Service, "The Saints of Pandharpur."

SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

INDIAN SECTION.

Thursday afternoons at 4.30 p.m.:—

January 13, February 17, March 16, April 6, May 18.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

February 1, March 7, May 2.

CANTOR LECTURES.

Monday afternoons at 4.30 p.m.:—

WALTER ROSENHAIN, D.Sc., F.R.S., Superintendent, Metallurgy Department, National Physical Laboratory, "Optical Glass." Three Lectures.

Syllabus.

LECTURE II.—DECEMBER 6.—History of optical glass manufacture—Fraunhofer, Guinand, Feil, Bontemps, Chance—Schott and Abbe—Hopkinson and Stokes—Efforts in England. The present method of optical glass manufacture—The furnace—The pot—Production and treatment—The process of melting and fining—Stirring and finishing—Cooling—Breaking up, selecting and moulding—Annealing—The final form of the glass.

LECTURE III.—DECEMBER 13.—The presen process of manufacture—General difficulties—Costliness—Cost of the pot—Time of production—Cost of melting—Raw materials—Low yield of good glass—Risks of the process—Risks of loss during melting—Failures due to striæ—Risks of contamination—Errors and variations of optical constants—Range of glasses demanded by opticians—Small quantities required—Need for large stock of optical glass. Special difficulties in England—Cost of raw materials and of labour—Refractories. Special difficulties connected with "new" glasses—Their chemical activity—Action on pots—Absorption of colouring impurities—Attainment of extreme optical properties. Need for research—The general problem—How to make good optical glass—Necessary improvements in pots and refractories, and in furnaces and methods of working—Utilisation of new materials and electric methods—The special problems relating to individual types of glasses—Optical and other properties to be realised simultaneously—The limitations of possible glasses—Optical properties of crystalline media—Future possibilities.

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m.:—

REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "Flemish Architecture." Three Lectures.

February 7, 14, 21.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

JUVENILE LECTURES.

These Lectures will be given on Wednesday afternoons, January 5 and 12, at 3 p.m. The first lecture will be given by Professor John Millar Thomson, LL.D., F.R.S., on "Crystallisation," and the second by Mr. James Swinburne, F.R.S., on "Science of some Toys."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 6...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Dr. W. Rosenhain, "Optical Glass." (Lecture II.)

Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 6 p.m. Mr. C. Turnor, "Land Settlement in England as affected by the War."

Brewing, Institute of (London Section), Imperial Hotel, Russell-square, W.C., 8 p.m. Mr. E. C. de Peyer, "Brewery Accountancy and Income Tax."

Engineers, Society of, Caxton Hall, Westminster, S.W., 7.30 p.m. Mr. A. Steiger, "The Modern Development of Water Power."

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. 1. Professor F. G. Donnan, "On the Use of Graphical Methods in the solution of Problems in Technical Chemistry." 2. Mr. T. C. Cloud, "The Transport of Material in the Form of Dust." 3. Mr. M. S. Salamon, "Sampling and Analysis of Beeswax."

TUESDAY, DECEMBER 7...Cold Storage and Ice Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m.

Marine Engineers, Institute of, The Minories, Tower-hill, E., 7 p.m. Mr. A. J. Lebeda, "Stern Shaft Lubrication."

Photographic Society, 35, Russell-square, W.C., 8 p.m. Mr. W. T. P. Cunningham, "Intensification."

Röntgen Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8.15 p.m. 1. Mr. L. A. Levy, "Some Remarks on Fluorescent and Intensifying Screens." 2. Mr. G. G. Blake, "Further Notes on Localisation."

WEDNESDAY, DECEMBER 8...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Lieut.-Colonel W. A. Tilney, "The Art of Finding your Way at Night without a Compass."

Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Dr. A. H. Gardiner, "The Foreign Script of Sinai."

Geological Society, Burlington House, W., 8 p.m.

Electrical Engineers, Institution of (Yorkshire Section), Philosophical Hall, Leeds, 7 p.m. Professor A. B. Field, "Some Difficulties of Design of High-speed Generators."

THURSDAY, DECEMBER 9...British Academy, in the Theatre, Burlington-gardens, W., 5.30 p.m. (Schweich Lectures.) Monsieur E. Naville, "The Text of the Old Testament." (Lecture I.)

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Child Study Society, at the Royal Sanitary Institute, 90, Buckingham Palace-road, S.W., 6 p.m. Dr. C. W. Kimmins, "Children's Interest in the War at Different Ages."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. A. C. Braham, "Autotype Printing, including the new White Carbon Tissue."

Optical Society, at the Chemical Society, Burlington House, W., 8 p.m. Mr. H. A. Hughes, "Improvements in Prismatic Compasses with special reference to the Creogh-Osborne patent Compass."

FRIDAY, DECEMBER 10...Malacological Society, at the Linnean Society, Burlington House, W., 7 p.m. 1. Dr. W. H. Dall, "Note on the Oligocene of Tampa, Florida, the Panama Canal Zone, and the Antillean Region." 2. Mr. G. K. Gude, "Description of two new species of *Angasella*."

Astronomical Society, Burlington House, 5 p.m.

Water Engineers, Institution of, at the Geological Society, Burlington House, W., 2.30 p.m. Mr. P. Griffith, "Notes on the definition of the term 'Domestic Purposes' in General and Private Acts."

Journal of the Royal Society of Arts.

No. 3,290. VOL. LXIV.

FRIDAY, DECEMBER 10, 1915.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 13th, at 4.30 p.m. (Cantor Lecture.) WALTER ROSENHAIN, D.Sc., F.R.S., Superintendent, Metallurgy Department, National Physical Laboratory, "Optical Glass." (Lecture III.)

WEDNESDAY, DECEMBER 15th, at 4.30 p.m. (Ordinary Meeting.) JOSEF DENYN, Carillonneur de Malines, and WILLIAM W. STARMER, F.R.A.M., "Carillons and Carillon Playing." W. G. MCNAUGHT, Mus.Doc., F.R.A.M., will preside.

THURSDAY, DECEMBER 16th, at 4.30 p.m. (Indian Section.) C. C. MCLEOD, President of the London Jute Association, "The Indian Jute Industry." SIR JOHN PRESCOTT HEWETT, G.C.S.I., C.I.E., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday afternoon, December 6th, DR. WALTER ROSENHAIN, F.R.S., delivered the second lecture of his course on "Optical Glass."

The lectures will be published in the *Journal* during the Christmas recess.

COLONIAL SECTION COMMITTEE.

A meeting of the Committee of the Colonial Section was held on Tuesday afternoon, the 7th inst. Present:—

Lord Blyth (Chairman of the Committee), Dugald Clerk, D.Sc., F.R.S. (Chairman of the Council), Byron Brenan, C.M.G., Richard Ernest Brounger, Hon. Sir John A. Cockburn, K.C.M.G., George Wilson, C.B., with Sir Henry Trueman Wood (Secretary of the Society), and S. Digby, C.I.E. (Secretary of the Section).

JUVENILE LECTURES.

Two of the Members of the Council—Professor John Millar Thomson, LL.D., F.R.S., and Mr. James Swinburne, F.R.S. — have kindly undertaken to deliver the Juvenile Lectures this year. Professor Thomson will give the first lecture on Wednesday afternoon, January 5th, at 3 p.m., his subject being "Crystallisation." Mr. James Swinburne will give the second on Wednesday, January 12th, at 3 p.m.; his subject will be "Science of some Toys." Both lectures will be very fully illustrated with experiments.

Special tickets are required for these lectures. They can be obtained, when ready, on application to the Secretary.

A sufficient number of tickets to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to a ticket admitting two children and one adult. Fellows who desire tickets are requested to apply for them at once.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

EXAMINATIONS, 1916.

ENGLISH FOR FOREIGNERS.

It has been determined to add to the subjects for the examinations for the present year the subject of English for French and Belgians This examination is intended specially for the benefit of Belgian refugees in England, but candidates of other nationalities can enter. The examination will be divided into two separate parts, Written and Oral. Candidates can enter for either part of the examination, or for both parts.

I. WRITTEN EXAMINATION.

The written examination will be held under precisely the same conditions as the other examinations of the Society. These are held (1) in April and (2) in May and June. Candidates can enter at any Centre in the United Kingdom where the examinations are held. A list of these Centres, which are about five hundred in number, with the general regulations, etc., can be obtained at the offices of the Society (John Street, Adelphi, London, W.C.), price 1*d.*, post free 1½*d.*

Information about the examination can be obtained from the offices of the Society, but no application for entry to the examination can be received there. Intending candidates should apply to the secretary of any of the Examination Centres for the April examination not earlier than February 1st, and not later than March 9th; for the May–June examinations not earlier than March 10th and not later than April 11th. Late applications will not be accepted.

The Society's examinations are arranged in three stages—Stage III., Advanced; Stage II., Intermediate; Stage I., Elementary. An examination paper in English for foreigners will be set in the Intermediate Stage and in the Elementary Stage. The ordinary standard of the Society's examinations will be strictly maintained, and candidates who have only an elementary knowledge of English are strongly recommended to enter for the Stage I. examination. If they enter for Stage II. (Intermediate), and are not successful, no certificate will be awarded. Candidates can, if they choose, enter for both stages; but this course is not recommended, and it involves the payment of two fees.

At all Centres outside the Metropolitan area the following will be the dates for the examination: Stage I., Monday, April 10th, and Monday, May 29th, commencing at 7 p.m. Stage II., Thursday, April 13th, and Thursday, June 1st, commencing at 7 p.m.

In London (this includes the area known as the Administrative County of London) the Society's examinations are under the superintendence of the London County Council, which is the local Education Authority for the Metropolis. The examination in Stage I. will be held only on Monday, April 10th, and that in Stage II. only on Thursday, June 1st. In both cases the hour will be 7 p.m. Applications to sit at the examinations in the London area should be sent within the dates before mentioned to the London County Council Education Offices, Victoria Embankment, London, W.C.

No application for general information should be addressed there, or to any other Centre, but only to the Royal Society of Arts.

In the Intermediate Stage certificates of a First and Second Class will be given. The minimum percentage of marks for these classes is 70 and 40 respectively. In the Elementary Stage the certificates will be of one class only. To gain a certificate, 50 per cent. of the total marks must be obtained.

A fee of 2*s.* 6*d.* will be charged for each candidate in the Intermediate Stage, and a fee of 2*s.* for each candidate in the Elementary Stage. The Local Committees are authorised to charge a fee to cover their expenses. It is hoped that this fee will not exceed 1*s.* per candidate.

All fees must be paid at the time of application, and at the Centre where the candidate desires to be examined.

Intending candidates will find all other details about the examinations in the before-mentioned publication, including a list of the Examination Centres.

The following are the syllabuses for the two stages:—

Stage I.—Elementary.

The examination paper will include:—

1. Translation into English of an easy French passage.
2. Translation into French of an easy English passage.
3. Rendering into French of English sentences and expressions.
4. A short essay or a letter in English on a given subject.

Candidates for this stage will not be expected to have an extensive vocabulary, and the rendering of the less common words in the translation tests from and into English may, if necessary, be given.

Stage II.—Intermediate.

The examination paper will include:—

1. Translation into English of one or more selected French passages.
2. Translation into French of one or more selected English passages.
3. Translation into French of English sentences and idiomatic expressions.
4. Other questions may be set to test the candidate's knowledge of the English language.
5. A short essay in English on a specified subject.

II. ORAL EXAMINATIONS.

These will be held under the same conditions as the Society's Viva Voce Examinations in

other modern languages, viz., at any date, at any of the Society's Examination Centres, when the Local Committee will undertake to make the necessary arrangements, and to pay a fee of 2s. 6d. per candidate for not less than 24 candidates.

Full details of these examinations will be found in the Examination Programme for 1916 (p. 13), and in the smaller publication containing the list of centres, etc. (p. 13).

It is suggested that any Local Committees desiring to hold a Viva Voce Examination in English should fix a date after the written examination in April.

Arrangements will be made for an examination in London in the month of June. Particulars will be supplied to any intending candidates, who may apply, not earlier than May 1st, to the Secretary, Royal Society of Arts, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

FOURTH ORDINARY MEETING.

Wednesday, December 8th, 1915; Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, in the chair.

The following candidate was proposed for election as a Fellow of the Society:—

Bennett, John, 57, Telford-avenue, Streatham, S.W.

The following candidate was balloted for and duly elected a Fellow of the Society:—

Thain, James Edward Vyner, C.S.P. College, Exmouth, Devon.

The paper read was—

THE ART OF FINDING YOUR WAY AT NIGHT WITHOUT A COMPASS.

By Lieut.-Colonel W. A. Tilney, F.R.G.S., F.R.A.S., late 17th Lancers.

With so much fighting now done at night, this art would appear to be most useful for soldiers to learn. The following is a brief account of its development and solution.

During the South African War I was often sent on long-distance night reconnaissances, and sometimes had Colonel Benson, who led the attack at Magersfontein, as a companion. We noticed that the Colonials, South Africans and natives were quite at home in the dark, whereas men from the British Isles were blind and helpless and lost their way when only a short distance from the column.

Colonel Benson often told me about the attack at Magersfontein, and described the difficulties of a night attack when the whole operation is dependent on one man with a compass.

As an aeronaut in Ladysmith, I had plenty of opportunities of foreseeing the great power aeronautics would have in warfare in the future, and that most of the effective fighting would be done at night.

At that time the Regulations described night operations as extremely hazardous, and warned the commander who undertook such operations that he did so at his own peril and was responsible for the results. Various expedients were suggested to enable the troops to keep their direction, such as that the route should be previously reconnoitred and marked by tins, pieces of paper and other devices; but how the reconnoitring party were to carry out this operation nobody has yet been able to understand. We found the Colonials never required this artificial help, and could move about on a starlit night as easily as in daylight and as fast as the nature of the ground permitted, whereas our Regulations laid it down that local guides should be procured, the route fixed by compass-bearing, and that the pace would rarely exceed two miles an hour.

With the whole operation dependent on the guide, and each individual blind and helpless in the dark, it is little wonder that the Regulations described a night attack as extremely hazardous. We foresaw if only we could devise some simple method for finding your way at night, which could be easily learnt by the rank-and-file of the Army, it would have a far-reaching influence on night warfare. In 1903, on my return to England, I took up the problem of "How to make a simple and practical use of the heavens," and ascertained from various Colonials, Basutos, Indians, and Arabs that they could instinctively read the heavens as a compass, this knowledge having been transmitted from father to son for generations.

My idea was to work out the exact movement and direction of the largest and most easily distinguishable lights in the heavens, so that the least educated had only to be able to recognise these signs by sight and their whereabouts would be known for every hour of the night. Thus the whole dome of the heavens would become a compass.

In 1904 I went through a six months' course at the Royal Geographical Society, under Mr. Reeves, in the hope that we should be

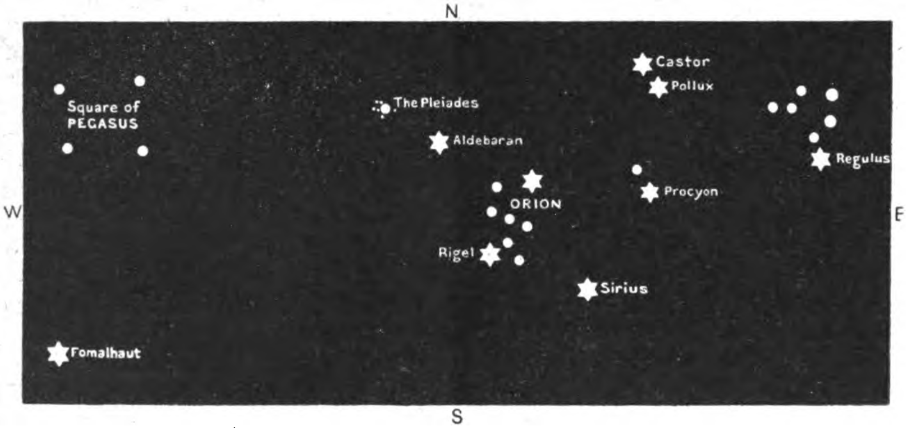

FIG. 1.

able to work out the positions of these various heavenly bodies, but found that the only means of doing so was by observation with a sextant or other instrument and the help of logarithms, etc.

Each observation and calculation took at least twenty minutes, so that to have made a calendar of the heavens by observation was an absolute impossibility.

Some of the highest navigating authorities took a keen interest in the idea, and I am deeply indebted to Mr. Reeves, Captains Nansen, Scott, Armitage, Smith and Blackburn for the help they gave me.

It was not until 1907 that we were able to get stars' bearings mechanically with the help of an orthographic projection of a sphere. Mr. Reeves' astronomical compass originated from this method. In 1909 Captain Blackburn, nautical adviser to the New Zealand Government, sent me his A B C Tables, and I then commenced to make a time-table of direction stars for use in India. We found when the true bearing of various first magnitude stars was known, that it made all the difference to night operations; unfortunately we could arouse little official interest in the project, for anything to do with astronomy was considered too complicated for the average soldier.

However, in 1911 Captain Weatherhead, Naval Instructor, Royal Navy, brought out a little book, with a foreword by Sir Robert Ball, in which he drew attention to the system I was then endeavouring to perfect, and, having received satisfactory reports from various cavalry regiments, I had every hope that the system would be of the utmost value to the Army, if we could only get it well known before the European war cloud had burst. In 1912 it was amply proved that troops could march with ease, rapidity and precision on a starlit night, now that the largest stars were labelled in the heavens, and soldiers began to realise that the ability to make long-distance rapid night marches gave troops the power to strike an enemy from a distance, if necessary, across

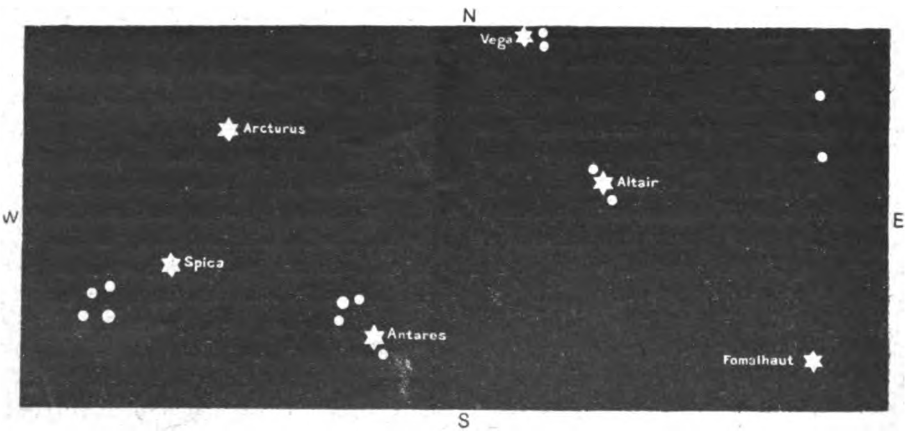

FIG. 2.

country, and that this system was an enormous improvement on old methods, especially in such countries as India and Egypt.

In June, 1913, being certain we were now on the straight road to overcome most of the difficulties connected with night operations, I made the double journey from Sialkot to Quetta to lecture to the Staff College, where I knew they would give the system a thorough good testing. The heat across the Sind Desert at this time of the year is terrible, and many of my friends warned me that such a journey at the hottest time of the year, with only four days' rest at Quetta, would tax the strongest constitution; but feeling sure that the Great War was not far distant, and that in case of any trouble in India this new power to make rapid night marches *without the help of guide* would be of the utmost value, I made the journey.

Severe tests were carried out, and the authorities reported: "we are perfectly certain that the system is a *most eminently sound one*," whilst the Indian Cavalry School reported: "The system has been tried at Saugor and has worked very well indeed. The students found no difficulty in determining the direction stars, and it is obvious that the faster the pace the truer is the direction." On my return to Sialkot, I realised that my friends' warning was true, and that unless I could get out of the heat I was done for. Fate decreed that I could not get home, and I almost died of heat stroke at Sialkot, so could not complete the tables for use in Europe till August, 1914, when Sir Douglas Haig wrote a foreword commending it to the notice of officers and men.

But it was too late, Armageddon had begun, and the work which I had hoped would be invaluable to the Army in this crisis was of no avail. Many officers affirm it would have saved hundreds of lives and casualties had this natural method been known at the earlier stages of the war; so let us explain the system in a few words, and then see how it would have affected

(*a*) The individual in open and trench warfare;

(*b*) Bodies of troops; and further.

(*c*) How rapid night marches can be conducted with ease, rapidity and precision on a starlit night.

The System.

Let us imagine fire balloons or beacons to be placed in the heavens north, east, south, west; it would then be easy enough to go in those directions. Similarly, if you wished to go, say, a hand's-breadth, to the right or left of the beacons, you could easily do so. The stars mentioned in "Marching or Flying by Night without a Compass" (published by Rees, 5, Regent Street, London, price 1*s.*) are the largest in the heavens and act as your fire balloons or beacons.

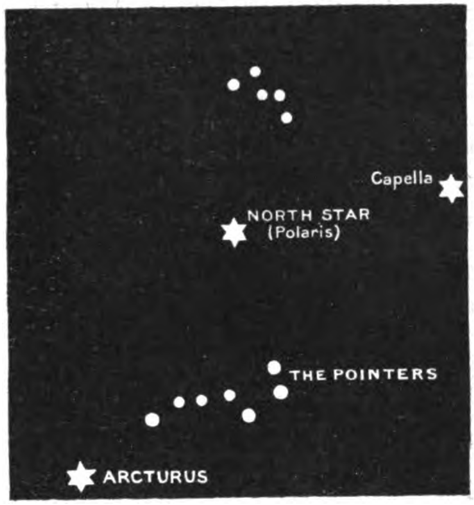

Fig. 3.

Now, if you put the front buttons of your coat on the North or other direction stars, your right and left breasts give you an angle of 45 degrees from the star and your shoulders a right angle. Also, it is only a matter of a little practice to be able to measure 15 degrees of horizon with your hand, so you can get any number of degrees to the right or left of your direction stars, and after a little practice it becomes second nature to recognise the points of the compass at sight, and you acquire the

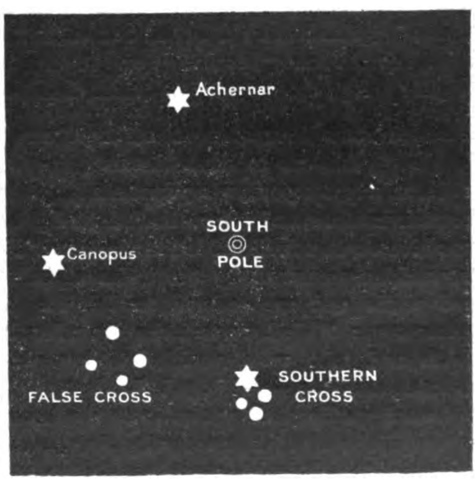

Fig. 4.

same sense of direction as bushmen, Arabs, and people who live far away from civilisation.

The North Star, Altair, and Vega are all-sufficient night guides for the rank-and-file during the spring and summer. For autumn and winter, the North Star, The Sword and Belt of Orion, Procyon and Regulus.

Its Influence on Night Operations.

At the present moment almost every individual from the British Isles is blind and helpless at night.

Let us remove this helplessness and we shall

(1) Give him confidence and self-reliance when engaged in night operations;

(2) Give him a sense of direction, so that he will not fire or dig trenches in the wrong direction;

(3) Be able to send individuals on messages and all communications will be much facilitated. Further,

(4) Slightly wounded men will not wander towards the enemy's lines.

(5) If we have to make an attack or retirement on a starlit night the whole brigade will know the line of attack or retirement, and so endless confusion will be obviated.

(6) Similarly, in the attack every man will know what he is doing, and it will be possible to rally in any desired direction.

(7) The stretcher-bearers will be able to go far afield and pick up the wounded.

Numerous other obvious advantages could be enumerated, for every man will be able to read the natural compass which has been in use ever since the world began, and this knowledge is attainable without taking much trouble, simply by observing the heavens when out at night and expending 3*d.* on the "Soldier's Night Guide" (published by Gale and Polden, Aldershot), or 1*s.* on "Marching or Flying by Night" (Hugh Rees, 5, Regent Street, London).

Finding your Way without a Map, Compass, Watch, or Star Table.

Let us suppose you are a private in the retirement from Mons, and after a hard day's fighting you bivouac in a field and fall fast asleep. You are suddenly aroused by the whizz of bullets and shells and are ordered to fall in. An officer says: "We have to retire five miles due south and take up a position to cover the retirement of the —— Brigade." Just as you are moving off a shell sweeps away the leading troops of the battalion, and by the time you are re-formed the advanced troops have disappeared. It is a pitch-black night with stars intermittently visible; between the clouds you see Vega, a very large bluish star with two little ones near it, making the letter V, almost half-way down in the heavens, which gives you roughly west, so you put your right shoulder on it and march south. Soon after you catch a glimpse of Altair, half-way down in the heavens, which gives you south-west, so if you go half left from Altair you will be going south. The troops around you have got badly knocked about, the country is rolling downs with occasional woods, and each time you have caught a glimpse of one of your direction stars you have taken some object to march on. You stop to help a pal who is badly hit, and as you look towards the north there is not a trace of the North Star or any northern constellation. You lay your pal in a cottage and then resume your journey. Vega and Altair are clouded over, you look eastwards and see Aldebaran rising, which gives you east, so you put your left shoulder on it, take a point to march on, and pursue your journey until you come across a battalion entrenching themselves on the rise of a hill.

Finding your Way to Trenches at Night.

Although the system was only perfected in June, 1915, soldiers of all ranks have begun to realise the simplicity and wonderful utility of being able to read the universal compass, the heavens, and we begin to hear how useful this knowledge has been found for guiding supporting troops up to the first-line trenches, etc.

The heavens cannot go wrong, and on a starlit night you can rely absolutely upon them to take you to your destination, once you grasp the rudiments of the system; you only require to know three or four first magnitude stars, for their exact position is given for every hour of the night in "Marching or Flying by Night without a Compass"

Let us see how it is done.

Say in Flanders on November 1st your battalion has to relieve another between 8 and 9 p.m. in an unknown line of trenches in a direction due east.

Look at the time-table of direction stars and you see the Pleiades (a large bunch of stars that nobody can mistake) is

$$\frac{85}{\text{E f N}} \text{ at 8 p.m.}$$

$$\frac{95}{\text{E f N}} \text{ at 9 p.m.}$$

Put this information in regimental orders, and when the battalion gets to the starting-point, the N.C.O's say to the men: "Do you see that ——— bunch of stars? The line of trenches we have to occupy is two miles from here in that direction; after you have gone one and a half miles you will come to a metalled road running north and south."

On arrival there the battalion will halt, close up and re-form. Every man then knows the line of advance, and on a starlit night they can move with ease, rapidity and accuracy.

Whatever direction you wish to go in, you will always find a convenient guiding star for any hour or hours of the night. Naturally, if you want to send messengers to the rear, all they have to do is to put their back on the Pleiades and their right shoulder on the North Star (if visible) and they will be going back to the starting-point due west.

That is not very difficult, and it has already been the means of saving many a man's life and getting troops out of difficulties.

Now let us deal with Larger Bodies of Troops.

Let us assume that the rank-and-file have been instructed in the art of finding their way at night and are now as night-perfect as any colonial, their fighting efficiency is increased 100 per cent., they are changed beings, and, like Basutos, are trained night fighters who can attack at night.

The great difficulty when large bodies of troops are making a converging attack is to keep direction, the whole advance being dependent on the guide or directing Staff officer.

Now, presuming all ranks can recognise their direction by a glance at the heavens, the Staff officers and leaders can proceed as fast as the ground and conditions permit, with ease and accuracy, by plotting out the star-bearings.

The Regulations say: "The most favourable conditions for night operations are a clear starlit night."

Example of a Converging Night Attack.

Say in Lat. 50° N. on December 1st two columns, A and B, have to make a converging attack on a line of trenches one and a half miles from the position of deployment.

Column A, direction of advance due east

Column B, direction of advance, south-east.

Time for moving off, 11 p.m.

The Staffs look up the respective guiding stars and ascertain, for Column A, Castor is due east at 11 p.m.

$$\frac{100}{\text{E. f N.}} \text{ at 12.}$$

also Regulus due east at 12.

This information should be passed to all ranks, and to obtain great accuracy bearing-cards as follows may be plotted, although when stars are as convenient as the above there is really no necessity to plot.

Bearing-card for Column A.

Point the star-bearing line towards Castor and follow the direction line.

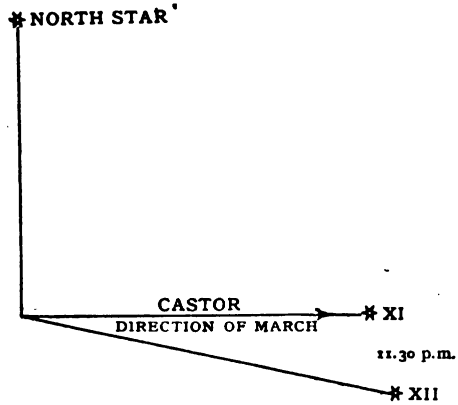

Fig. 5.

For Column B, direction S.E.

Sirius is S.E. at 11 p.m.

$$\frac{150}{\text{E. f N. at 12.}}$$

Of course, 45 degrees to the south of Castor and Regulus would also give S.E.

These should be plotted on a full-size card.

Bearing-card for Column B.

Several divisions who practised this form of attack under natural conditions had these bearing-cards lithographed off in the afternoon and distributed to the leaders, and it worked very well indeed.

The obvious advantages of attacking by star-bearings are:—

(1) All bodies of troops are moving on true bearings in the same direction and can move as fast as the ground permits.

(2) All ranks know the direction and what they are doing. Their confidence and self-reliance is therefore increased.

Besides the advantages mentioned above, it has been found that distances, intervals and

communication can be easily kept up and the formations can be changed according to the

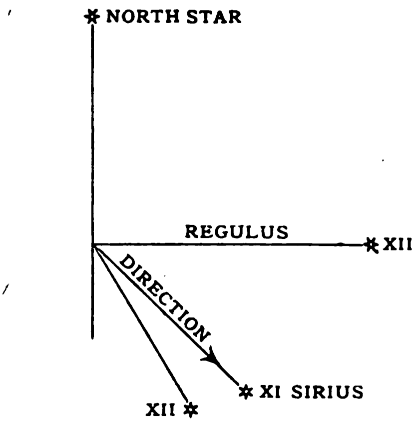

FIG. 6.

nature of the ground. In short, most of the endless confusion connected with night operations is avoided.

RAPID NIGHT MARCH ACROSS COUNTRY.

I have purposely kept the example of a rapid night march till the last, as, except in such countries as Asia Minor, there is little scope in these days of trench warfare for bringing into play this new power to strike an enemy at a distance.

Say, in Persia, Lat. 30° N., on September 15th (time-table of "Direction Stars for India"), a mounted column wishes to make a long-distance rapid night march, in order to surprise an enemy's encampment twenty-five miles distant.

Direction of march due west, country open and passable for all arms. There is only one road which goes through some hills to the north, and the enemy holds these positions in strong force.

On examining the map, a bee-line shows no very serious obstacle; but in order to check distances covered, and to ensure that the column is keeping an accurate direction, the following features are noted on an ordinary piece of paper in large black figuring, thus :—

Distance.	Feature.
After going 2 miles.	Stream.
,, ,, 4 ,, further.	Unmetalled road running N.E. and S.W.
,, ,, 5 ,, ,,	Sugar-loaf hill.
,, ,, 4 ,, ,,	Small village.
,, ,, 3 ,, ,,	Strip of cultivated ground.
,, ,, 5 ,, ,,	Village at the foot of low line of hills.
23 miles.	

The column halts, scouts are sent forward to ascertain the exact whereabouts and dispositions of the enemy.

On the reverse side of the card or piece of paper the following information is given :—

GENERAL DIRECTION WEST.—DIRECTION STAR, VEGA.

Time.	Bearing.
IX.	$\frac{55}{\text{W. f N.}}$
X.	60
XI.	60
XII.	60
I.	55
II.	50
	W. f N.

We will allow six hours for the twenty-three-mile march, including halts (it was found in numerous test marches with mounted troops that five miles per hour could be comfortably covered over easy country); so, as Vega has set at 2 a.m., we must switch on to another star for the last hour. On looking at the time-table of direction stars, we see Fomalhaut is

$$\frac{135}{\text{W. f N.}} \text{ at 3 a.m.,}$$

so 45 degrees to the right of that star will give us due west.

Here are the bearing-lines for the march, but they are really not required when using such a constant star as Vega is in this case.

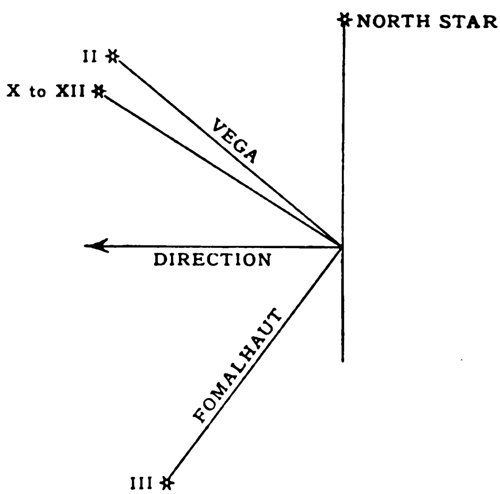

FIG. 7.

In all night work this power to read the heavens will be found to be extraordinarily useful, for if the body of troops has a guide you can see in a moment if he is taking you wrong.

Now some will say to themselves: "What happens if the heavens become overcast whilst you are on this long night march? You will have to creep along at two miles per hour on compass bearings."

This difficulty has recently been overcome by the invention of the Ani-Pace Compass (Hugh Rees, 5, Regent Street, London), an instrument with no magnetic variation, which gives true bearings, can be read by touch and sound, and once set is unaffected by oscillation. When any stars or heavenly bodies are visible it at once gives their true bearings and obviates the necessity to draw out the star-bearing and direction lines, as above described.

When no stars are visible, it enables you to proceed on true bearings as fast as the nature of the country permits.

So we have conquered most of the difficulties connected with night operations and, as Sir Douglas Haig says, the method has been tested and found successful. Another well-known authority remarks: "The system is exceedingly useful because it is so simple, and is just what was wanted in the Army when so much fighting is done at night; it will be of the greatest service to others besides soldiers."

If these predictions are fulfilled, and it proves to be a real service to the Army in this great crisis, those who have helped to perfect the system will be more than well rewarded.

I will now show you the direction stars on the screen, and teach you in five minutes how to find your way at night without a compass, star-table or any instrument. After that I shall be most grateful for your fullest criticism.

At the conclusion of the reading of the paper, a number of questions were asked by members of the audience, to which Colonel Tilney replied; and, on the motion of the Chairman, a hearty vote of thanks having been accorded to Colonel Tilney for his interesting and instructive paper, the meeting terminated.

COLLISIONS AT SEA.

At a recent meeting of the Royal Society, Professor J. Joly, Sc.D., F.R.S., read a paper on "A Method of Estimating Distances at Sea in Fog or Thick Weather." The method proposed is based upon the different velocities of disturbances in differing media. If aerial and submarine signals are simultaneously emitted at a lighthouse station or lightship, the lag of the aerial compared with the submarine sound is about 4·3 seconds to the nautical mile. An approaching ship picking up the signals and measuring the lag to an error even of one second becomes aware of her distance to less than one-quarter of a mile. Similarly wireless signals and submarine signals, or wireless and aerial signals, may be used.

If the faster moving signals be sent out in groups, the individual signals, being spaced to regular intervals, say, of one second, and the slower moving signal be always emitted simultaneously with the first signal of a group, the navigator has only to count the faster signals till the slower signal reaches him, in order to estimate his distance from the signal station. In this case the signals themselves tell him his distance, and no actual time-measurements are required on board ship.

It is shown that this system enables the mariner to determine his position completely under all circumstances which may arise.

Professor Joly also read a second paper dealing with an extension of this method to the problem of avoiding collision in fog.

It is shown that if vessels possess the means of emitting a loud and crisp sound signal which can be sent out simultaneously with a wireless or a submarine signal, the determination of distance rendered possible thereby, along with wireless information as to course and speed, will enable the navigator on each ship to determine with certainty (1) whether there is risk of collision or whether there is no risk, and (2) the point upon his own course and the moment at which collision is threatened.

The solution of the problem is based upon the fact that at each instant the rate of mutual approach is the maximum if the ships are advancing so as to collide. A simple geometrical construction, which by its character is unlikely to involve error, enables the mariner to solve the problem immediately the signals are received.

CASEIN FROM INDIA.

The *Indian Textile Journal* gives some particulars of the manufacture of casein in India. Owing to difficulties of transport, it is in many places impossible to distribute milk in a fresh condition. By converting it into casein, a dry, non-decaying substance that may be packed in boxes or bags, it may be carried with ease, and it finds a ready sale for use as a substitute for celluloid, over which it has the advantage of not being inflammable. For some years a profitable business has been conducted at Anand, in the Baroda State, in the production of casein for export. The process resembles the manufacture of cheese. The skimmed milk is coagulated by rennet, precipitated by hydrochloric acid, and separated in a centrifugal filter. The result is a whitish or yellowish mass which, after drying, is the casein of commerce. There are several ways of separating it, one of the most recent being by a current of electricity, which is said to be the cheapest where current from water or wind power is available.

Casein has also been extracted on a large scale

from the soya bean after the oil has been removed by pressing. One of the most important uses of casein is the production of galalith, which is used to imitate ivory, tortoiseshell, and celluloid. It is cheaper than the last-named substance. Galalith is made from casein by pressure, which forms it into cakes that are then compressed to the desired thickness. It is translucent, and can be given any colour. It has no bad odour, and will take a high polish. When heated to 150° C. in a bath of oil, it can be moulded by pressure. It is already used for a great variety of low-priced articles, including waterproofs, that do not soften and stick together like rubber goods in a tropical climate. It is made into plates, rods, and tubs, like ebonite. Galalith factories are increasing in number in Europe. In 1910, at Lurgère (France), 440,000 lb. of casein were converted into galalith — the produce of thirty-five dairies that sent their milk to the factory. It takes 15·85 gallons of milk to produce 2·20 lb. of galalith.

Milk casein is also used for sizing paper which is waterproof and resembles parchment. Silks, artificial textiles, leather, films, and plastic substances are prepared with the aid of casein, and in printing calico a solution of vegetable casein and borax is sometimes used as a thickening agent, which adds brilliancy to the colour and gives a silky appearance.

THE EXPORT FRUIT INDUSTRY OF NEW ZEALAND.

During the planting season 1914 has occurred the greatest development in laying out apple orchards that New Zealand has yet experienced. Some quarter of a million fruit trees—mostly apples of approved commercial export varieties—have been planted.

The Nelson district has always led the way in orchard planting; illustrative of this is the fact that apples exported from Nelson Province in 1912 totalled 18,000 cases; 1913, 33,000 cases; 1914, 66,000 cases. The 1915 season promises greatly to exceed the 1914 season.

Most of the work of new planting has been carried out by large companies acting on behalf of intending orchardists who are not yet resident. The methods adopted by these companies are similar in each case. A supervisor, who is a fruit expert, is appointed for each estate, and a staff of men under him are engaged. The whole of the planting work, including clearing, ploughing, purchase of trees, fencing, etc., is carried out under this supervision; and by this staff the orchards so planted are maintained, under the same management, until in bearing, spraying, pruning, cultivating and all necessary work being carried out by them. This method is agreeable to many purchasers, as it enables men, who could not otherwise afford the five or six years' wait, to remain in whatever position they may hold until their orchard is a revenue-producing concern.

The varieties of apples favoured in the Nelson district are Cox's Orange Pippin, Jonathan, Sturmer, Munroe's Favourite, Delicious, Scarlet Nonpareil, Washington and Alfriston.

Shipping facilities from the Nelson district are provided by three ports. The Nelson harbour is, of course, the largest, but both the western entrance and the Motueka harbours are capable of taking and loading coastal boats to carry the fruit to Wellington for sale or for transhipment for export to the Northern Hemisphere and to South America.

Dealing with other districts, extensive planting is proceeding in North Auckland this year. It looks, with the enormous area of land available, as if the apple output from this district will in years to come exceed that from Nelson. The varieties planted are somewhat different, the most successful being Doherty, Northern Spy, Gravenstein, American Horn, and Lord Wolseley.

Central Otago is also pushing ahead with smaller areas, and individual growers are turning out splendid fruit. Up to date all this fruit has been sold locally for the Dunedin market.

With regard to markets, at present South America is the greatest consumer of New Zealand apples. The buyers from this continent are demanding more fruit than New Zealand can supply. This may not, however, always be the case, as in four years' time it is anticipated that the Dominion will be able to export from a million and a half to two million cases of apples per annum. It is therefore necessary for the growers to organise in order to develop further markets in other parts of the world. According to the report for 1914 of the Wellington Chamber of Commerce, there should not be any very great difficulty in organising these markets, but the day of the individual grower marketing his own fruit is rapidly passing away. It is desirable that co-operative societies or companies be formed whose functions would include picking, grading, and cool-storing of the fruit of the surrounding growers. This could be handled by co-operative companies, with growers as members, on similar lines to co operative dairy companies. The advantages of co-operation in the preparation of the fruit for market and in selling the fruit are evident. A brand could be established for large quantities of fruit graded by experts, instead of a number of different brands each for small quantities of fruit, and uniformity in the quality of fruit supplied could be ensured. Buyers from other parts of the world will not deal with small quantities of fruit, and they must be absolutely sure that the fruit supplied will be regular in size, colour, and quality. Too much stress cannot be laid on the necessity for co-operation, and the leading men in the industry seem fully alive to this fact.

This year, in spite of the somewhat dry season, in all probability over 100,000 cases of apples

will be exported. South Americans are offering at from 6s. to 7s. per case f.o.b. Wellington. The present apple export trade from New Zealand is not large, but it is evident it will show enormous development within a few years. Growers of apples for export must realise that their product has to compete in the world's markets. It is essential, therefore, that every care be taken in growing fruit suitable for particular markets, that the quality and colour are right, that the apples are uniform in size and adequately packed. There is no reason why fruit co-operative packing companies should not do for the apple-export industry what the co-operative dairy factories have done for the dairying industry.

ENGINEERING NOTES.

Railway Progress in China.—Nearly forty years ago the first attempt to construct a railway roused the Chinese to such fury that the mob tore up the rails and pitched them into the sea. Later on calmer counsels prevailed; but it was not until the year 1878 that the first rail of the famous Shanghai-Woosung line was laid by Mrs. G. J. Morrison, an Englishwoman. A 30-in. gauge, with 26-lb. rails, was adopted. A locomotive called the "Pioneer," weighing only 22 cwt., specially designed in England, made the first locomotive run on February 14th of that year, that is, exactly fifty years after the "Rocket" made its debut. Through the cleverness and persistent efforts of the promoters, the road was finally completed, the total distance being some seven miles. Step by step the extension of railways went forward. Thus in 1907—that is, when the "localisation" movement had started—important lines such as the Pekin-Mukden, the Pekin-Hankow, the Pekin-Kalgan, the Tientsin-Pukow, the Shanghai-Nankin, the Kirin-Changchun, the Chengtai, the Canton-Kowlun, the Chuping, the Pien-lo, and the Tao-Ching railways, etc., with a total length of more than 4,000 miles, were all for the greater part open to traffic. The first railway of importance financed entirely with Chinese capital and built by Chinese engineers was the Pekin-Kalgan line, which is a short section of about 125 miles of the Pekin-Suiyuan Railway, the whole system being about 400 miles. It passes through very difficult country. In fact, from an engineering point of view, it is the most difficult line now existing in China. Starting from Fengtai, where it connects with the Pekin-Mukden line, it proceeds in a northern direction, along the west wall of Pekin, to the Nankow Pass, in the neighbourhood of the Ming Tombs. This section of about thirty-three miles is comparatively easy; but from this point up, for a distance of about fifteen miles, including the Nankow Pass, where the altitude suddenly rises to over 2,500 ft., the country is difficult. The road winds along deep gorges and high mountains, necessitating four tunnels aggregating a mile in length and numerous bridges, viaducts, deep cuts, and high embankments. At first many people thought that it was almost an impossible piece of engineering work. For some of the above details we are indebted to the *Manchester Guardian.*

A Pioneer in Aviation.—Recently at Sydney, N.S.W., Lawrence Hargrave passed away, a noted man in many ways, particularly in the science of aviation before it reached its practical stage. The late Mr. Hargrave, who did so much to advance the science of aviation, was born in England, but he spent the greater part of his life—forty-eight years of it—in New South Wales. He was the son of the late Mr. Justice Hargrave. The death of his own son, Geoffrey Hargrave, who was killed at the Dardanelles a few months ago, was a great blow to him, and undoubtedly hastened the end. Geoffrey Hargrave, like his father, was an engineer by profession, and his death in action has cut short a very promising career. The name of Lawrence Hargrave will be remembered the more as time goes on. He worked for some years as an assistant astronomical observer at Sydney Observatory, but gave up his work there and thereafter devoted most of his life to the study of aeronautics; and certain it is that the present-day successes in mechanical flight are due largely to the work of this man. Thirty years ago Hargrave was studying the flight of birds, making working models embodying the principles of their motions. The success of the models convinced him of the possibility of mechanical flight; and in a paper which he read before the Royal Society of New South Wales in 1884, he gave particulars of his discoveries in modest and simple terms. "I have strung together my thoughts, experiments and deductions that refer in any way to the trochoidal plane," he said, "pointing out where I see Nature working with it, and how it can be used by man for the transmission of force; and I think that if other members have heard of or made similar observations they should bring them forward, so that my mistakes may be corrected by comparison with the ideas of others, and also that the truth may be elicited about a matter that does not seem to get its fair share of investigation. The trochoidal action of five muscles and legs seems so plain that I could not help being led to theorise on the action of wings in flight. I say theorise, because I have not a flying machine to show you; but the chain of evidence is so complete that I have no doubt it soon will be accomplished, without the aid of the screw or the gas-bag. These are my views, and if you think there is any novel truth embodied in them, this society is welcome to any of the laboratory models that aided me in finding it out." Eleven years later, in 1895,

Hargrave conducted a remarkable experiment, utilising his invention of the cellular or box kites, the forerunner of the modern aeroplane, to lift him from the ground. The principle was adopted by practically every military nation in the world for signalling purposes. Other papers of his have obtained a European reputation. It was Hargrave who lifted human flight from the realm of dreamland into realisation; it was upon his discoveries that other men built, who have become famous in the world of aeronautics—the Wright brothers and Farman, for instance. For thirty years he worked steadily on the problems of aerial engineering, constructing models, improving on them, and ever reaching higher stages. It is said of him that for one of his boilers he required 190 ft. of copper tubing, and, finding that the pipe on sale in Sydney was too thick for his purpose, he shaved the 190 ft. to the thinness required, and had to invent a lathe to do it. And all the time, whilst his work was unappreciated, and his efforts had even ridicule heaped on them—aeronauts in other lands were working on his ideas. It was but one more illustration of the truth of the saying that a prophet is without honour in his own country. It is not to our credit that when, some years ago, Mr. Hargrave offered to hand over all his models to the Australian Government, so that they might be available for inspection by other inventors and the public generally, they could find no room for them anywhere. The same indifference was shown in England. So they were presented to Germany, and to-day they may be seen in the Deutsche Museum at Munich, and it is believed that the "Taube" aeroplane, which has been so prominent in the war, is fashioned on one of these Australian models.

Closure of the Hell Gate Arch at New York.—Recently the south bottom-chord section forming the first connection between the east and west halves of the 977 ft. 6 in. Hell Gate arch of the New York Connecting Railway, the longest arch-span in the world, was fitted into place with 3½ in. to spare. The member was raised and set in twenty-five minutes by the two travelling cranes which had been built on each side of the arch. The closing member of the north truss was successfully set in the same length of time, although the hot sun had expanded the bridge till there was less than 2 in. clearance in which to manipulate the 90-ton chord section. The two diagonals from the top of the east side of the panel to the bottom of the west side were next set with half the diagonals from the bottom of the east side. The closing panel is a true centre panel, and the temporary hinged bearing that will support the arch till the full dead load is being carried is in the bottom chord at the west end of this panel. The next day the jacks on the main posts of the backstays, which rest on the two main piers, were lowered varying distances from 15 to 20 in. to bring the centre hinge to a bearing. This operation was successfully accomplished, and the eyebar-ties over the backstay posts were released in about one hour and a quarter, through the use of a multi-party telephone line with stations at the centre, at each backstay jack, at each counterweight, and at the office. Men stationed at all these points were thus kept continually informed of all relative movements, each station being directly connected with all the others, and all "listening in" to the orders and reports from each of the points. Previous calculations of the required movements at each jack had been made to ensure even lowering at the top hinges, so that no appreciable shear would be transmitted through the centre chords. No lives were lost in these operations; safety and accuracy were considered of primary importance. When completed with hangers and floor system there will be nearly 20,000 tons of steel in the arch-span. The east ends of the top-chord sections in the centre panel were at once riveted up, but the west ends will be left free to move until the arch has reached its final position under full dead load. In order finally to match up this panel point it was thought best to leave one pair of members blank and drill by the other pair after the arch was under full load. As temperature changes on any ordinary day would throw this work out of alignment before holes could be drilled to insert enough drift pins to withstand the temperature stresses, some means had to be provided for holding the top-chord sections rigid at this panel point. This is accomplished by a 7-in. diameter bolt inside each top-chord section parallel to its centre line. These bolts are strong enough to take all the temperature stresses and hold the ends of the top-chord sections rigid till they can be drilled and riveted.

The Future Military Aeroplane.—We learn from the *Scientific American* that Germany will soon begin the construction of giant aeroplanes—triplanes—of enormous dimensions. These machines are to be three times as big and strong as the ordinary flying machine. They are to carry as many as twenty men. This crew will work four machine guns and one light field piece mounted in a special little armoured turret. Eight Maybach motors, similar to those used by the Zeppelin airships, are to drive the machine through the air. The motors will be coupled in pairs and drive four propellers. The propellers may be shifted in position, so that they serve for steering in a horizontal plane. Manual steering will be used only for elevating or depressing the machine. All other movements will be effected by the motors. The triplane will fly with two propellers only if need be, and travel at high speed when four are turning. The machine is to be armoured.

OBITUARY.

ZACHARY MERTON.—By the death of Mr. Zachary Merton, which occurred recently in Cadogan Gardens, a number of London charities lose a generous benefactor.

Mr. Merton, who was of Jewish race, was born in England in 1843. His father was of German descent, but was a natural-born British subject. Mr. Zachary Merton was a partner in the firm of Henry R. Merton & Co., and when it was converted into a limited liability company he became a director and one of the principal shareholders.

About 1887 his attention was called to the condition of the many thousands of underfed London children, and to the lack of proper training for poor boys as soon as they left the elementary schools. He consulted Mr. H. Gardner, master of what was known as the Hornsey Road Ragged School, and by his advice he founded and entirely supported a trade school or institute, first located in George's Road, Holloway, and afterwards in larger premises in Holloway Road. This institute has flourished for twenty-eight years, and on it from first to last Mr. Merton spent £11,000. With a similar regard for the health, the rational amusement, and the elementary training in handicrafts of the London children, Mr. Merton for several years subscribed some £750 a year to the Evening Play Centres, which now provide for about 25,000 boys and girls. This sum practically pays the cost of three play centres.

Of various hospitals Mr. Merton was a most generous supporter, and of the Charity Organization Society also. To the latter he contributed, since the war began, £40 a week to meet cases of poverty indirectly caused by the war. He helped other sufferers in other ways, and was specially on the look-out for cases of distress caused by the pressure of the "improvements" which so constantly benefit the many and ruin the few. An instance was his care for drivers of horse omnibuses and hansom cabs, forced out of work by motors and taxi-cabs. Whenever he could he took a hansom, got into conversation with the driver, and if he found him losing his work he arranged to pay for his being taught to drive a taxi-cab.

Mr. Merton was elected a member of the Royal Society of Arts in 1890.

NOTES ON BOOKS.

THE COLONISATION OF AUSTRALIA (1829-42). By Richard Charles Mills, LL.M., D.Sc. (Economics). London: Sidgwick & Jackson, Ltd. 10*s.* 6*d.* net.

The years 1829 to 1842 were the turning-point in the history of Australia. Previously to this period the colony was merely regarded as a dumping-ground for the superfluous and least desirable portion of the population of the mother country, and it received an annual increment of the worst of our criminals. It was known as "the fifth or pickpocket quarter of the globe." British ideas about colonisation could then hardly be said to exist; the condition of colonial land laws was chaotic; and Australia seemed to be heading rapidly for ruin. From this fate she was saved mainly through the instrumentality of one man, Edward Gibbon Wakefield. The great merit of this book is that it gives the first full and adequate analysis of Wakefield's work—a theme which must possess enormous interest for all students of colonial history.

The career of Wakefield is most remarkable. After an idle and profitless youth he found himself at the age of thirty sentenced to three years' imprisonment in Newgate for making a runaway match with a very young heiress, whom he lured from school. What would have meant permanent ruin for most men was salvation for Wakefield. Brought to his senses by the rude shock of his sentence, he devoted himself to the closest study of colonies and colonisation. To the surprise of those who had been his friends, he turned out to be a man of ideas, and his series of "Letters from Sydney" (written while he was still in Newgate) attracted instant attention. He was master of a vivid and nervous style, and so graphic was his account of Sydney that no one suspected the letters to be the work of any one but a colonist. He described the economic, social, and political conditions of New South Wales, and he suggested the remedies which time has proved to be the right ones. As an instance of his prophetic insight, it may be mentioned that he even went so far as to point out the necessity of instituting irrigation works, which has only been thoroughly realised in Australia in recent years.

Mr. Mills gives a terrible account of the conditions of emigration and of emigrants at the time when Wakefield began his labours. A part of Wakefield's scheme was to sell land in Australia in small quantities, instead of the enormous tracts of which the landed estates then consisted, and to utilise the proceeds as a fund to promote emigration. He saw that the great need of the colonies was labour of a good class, and he was remarkably successful in his efforts to secure it.

Wakefield is, perhaps, even more intimately associated with New Zealand than with Australia. In 1837, when the New Zealand Association was established, he became its managing director, and, indeed, by a bold coup he compelled the British Government to annex the country just in time to anticipate a similar step on the part of France. And it was to New Zealand that he went in 1853, after a constitution had been granted to the colony, and he continued to live in Wellington till his death, nine years later.

It is fitting that this tribute to Wakefield should come from Mr. Mills, who himself hails from Melbourne. He has made a very careful and complete study of this remarkable man and his methods, and his book is a notable addition to the series of monographs by writers connected with the London School of Economics and Political Science.

GENERAL NOTES.

Further British Awards at the Panama Exposition.—The second list of awards at the Panama-Pacific Exposition has been received from the British Commissioner at the Exposition. The first list was published in the *Journal* of September 10th last. The following are the successful exhibitors:—*Department of Fine Arts.*—Group I. (gold medal), C. W. Simpson, George Sauter, Julius Olssen, Harold Speed, Laura Knight, H. Hughes Stanton, Harold Knight; (silver medal) W. G. von Glehn, R. G. Goodman; (bronze medal) Louise Ginnett, J. Ker Lawson, Isobel A. Dods-Withers, Herbert Draper, W. E. Christmas, Jane Emmett von Glehn, L. Richmond; Class II. (gold medal), R. G. Goodman. Group II. (medal of honour), Frank Brangwyn; (bronze medal) Alfred Bentley. *Department of Machinery.*—Messrs. John Henry Andrew & Co., Ltd. (tool steel and mining steel), gold medal; Messrs. Edward G. Herbert, Ltd. (tool steel and file steel testing machines), gold medal; Messrs. Seebohm & Dieckstahl, Ltd. (steel manufacturers), gold medal. *Department of Transportation.*—Messrs. Thomas Cook & Son (guide-books, maps, etc.), medal of honour; Messrs. Rolls, Royce, Ltd. (automobiles), grand prize; Coventry Chain Company (chains and gear wheels), gold medal. *Department of Agriculture.*—Messrs. John Gillon & Co., Ltd. (Scotch whisky), medal of honour; Messrs. E. & J. Burke, Ltd. (Dublin porter and Bass's ale), medal of honour; Messrs. E. & J. Burke, Ltd. (sloe gin), medal of honour; Messrs. E. & J. Burke, Ltd. (three star Irish whisky, dry gin, and Old Tom gin), gold medal; Messrs. Cantrell & Cochrane (ginger ale), medal of honour; Messrs. John Dewar & Sons, Ltd. (Scotch whisky), gold medal; Clifford-Wilkinson Tan-San Mineral Water Company, Ltd. (natural aerated mineral water), gold medal. *Department of Horticulture.*—Messrs. Kelway & Sons (flowering annuals), medal of honour; Messrs. Sutton & Sons (outdoor flowering plants), medal of honour; Messrs. Sutton & Sons (seeds), gold medal; Messrs. Sutton & Sons (antirrhinums), gold medal; Messrs. Sutton & Sons (salpiglossis), silver medal; Messrs. Sutton & Sons (Cosmea-miniature yellow), bronze medal; Mrs. Alice Martineau (model of Hurst Court Garden), silver medal.

China's Fishery Schools.—The first fishery school was established at Woosung in 1904 by the Kiang-Chi Fishery Company. The provinces of Chili and Mukden followed successively, and the curriculum in these schools was modelled after that of the Woosung School. Besides these schools there have also been established fishery training schools for the practical improvement of fishing methods. In the third year of the Republic (1914) the Ministry of Agriculture and Commerce started to establish training schools along the coast. Several have already been established in the provinces of Chili, Chekiang, Fengtien, Fukien, and Kwangtung. In the province of Chekiang alone three training schools have been established. The people engaged in the fishing industry all welcome these schools, and it is expected that they will be greatly benefited.

Pomace as Cattle Food.—The Board of Agriculture draw the attention of stock keepers living in cider-making counties to the value of pressed apple pomace as a palatable feeding-stuff for stock. The fresh pomace, which contains from 70 per cent. to 80 per cent. of water, according to the efficiency of the pressing and the variety of apple, should be fed in combination with more concentrated feeding-stuffs, and not as a complete ration in itself. On the basis of composition it has a considerably higher feeding value than mangolds, and is not unlike wet brewer's grains, though it contains less protein. As it ferments rapidly, it should be fed quite fresh; or it may be preserved with salt and made into a kind of silage. When dried the pomace forms a valuable concentrated feeding-stuff.

Argentine Oil Output.—According to official figures issued by the Argentine Minister of Agriculture, the output of the Comodoro Rivadaira oil-fields since the beginning of their exploitation in 1907 is as follows (in barrels of 42 gallons):—

			Barrels.
1907	1	well	101
1908	1	,,	11,472
1909	3	wells	18,831
1910	3	,,	20,753
1911	3	,,	13,119
1912	3	,,	47,007
1913	7	,,	130,618
1914	8	,,	275,500
Jan. 1st to March 26th, 1915	9	,,	85,344

The grand total of all the wells since the commencement of the industry to March 26th, 1915, is 602,745 barrels.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

December 15.—Josef Denyn, Carillonneur de Malines, and William W. Starmer, F.R.A.M., "Carillons and Carillon Playing." W. G. McNaught, Mus.Doc., will preside.

January 19. — Lawrence Chubb, "The Common Lands of London: the Story of their Preservation." Lord Farrer will preside.

January 26.—J. Arthur Hutton, Chairman of the British Cotton Growing Association, "The Effect of the War on Cotton Growing in the British Empire."

February 2.—S. Charles Phillips, M.S.C.I., "Paper Supplies as affected by the War."

FEBRUARY 9.—PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

FEBRUARY 16.—THE HON. LADY PARSONS, "Women's Work during and after the War."

FEBRUARY 23.—MISS H. B. HANSON, M.D., B.S., D.P.H., "Experiences in Serbia."

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

DECEMBER 16.—C. C. MCLEOD, President of the London Jute Association, "The Indian Jute Industry." SIR JOHN PRESCOTT HEWETT, G.C.S.I., C.I.E., will preside.

Dates to be hereafter announced:—

R. W. SETON-WATSON, D.Litt., "The Balkan Problem."

CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

REV. P. H. DITCHFIELD, "The England of Shakespeare."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

VICTOR HORTA, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

CHARLES DELCHEVALERIE, "Belgian Literature."

LESLIE URQUHART, "The Economic Development of Russia."

PROFESSOR T. G. MASARYK, "The Slavonic Peoples."

G. P. BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., late Survey of India, "The Romance of the Indian Ordnance Survey."

C. A. KINCAID, C.V.O., Indian Civil Service (author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.), "The Saints of Pandharpur." LIEUT.-COLONEL SIR DAVID W. K. BARR, K.C.S.I., will preside.

SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

INDIAN SECTION.

Thursday afternoons at 4.30 p.m.:—

January 13, February 17, March 16, April 6, May 18.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

February 1, March 7, May 2.

CANTOR LECTURES.

Monday afternoons at 4.30 p.m.:—

WALTER ROSENHAIN, D.Sc., F.R.S., Superintendent, Metallurgy Department, National Physical Laboratory, "Optical Glass." Three Lectures.

Syllabus.

LECTURE III.—DECEMBER 13.—The present process of manufacture—General difficulties—Costliness—Cost of the pot—Time of production—Cost of melting—Raw materials—Low yield of good glass—Risks of the process—Risks of loss during melting—Failures due to striæ—Risks of contamination—Errors and variations of optical constants—Range of glasses demanded by opticians—Small quantities required—Need for large stock of optical glass. Special difficulties in England—Cost of raw materials and of labour—Refractories. Special difficulties connected with "new" glasses—Their chemical activity—Action on pots—Absorption of colouring impurities—Attainment of extreme optical properties. Need for research—The general problem—How to make good optical glass—Necessary improvements in pots and refractories, and in furnaces and methods of working—Utilisation of new materials and electric methods—The special problems relating to individual types of glasses—Optical and other properties to be realised simultaneously—The limitations of possible glasses—Optical properties of crystalline media—Future possibilities.

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m.:—

REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "Flemish Architecture." Three Lectures.

February 7, 14, 21.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

Juvenile Lectures.

These Lectures will be given on Wednesday afternoons, January 5 and 12, at 3 p.m. The first lecture will be given by Professor John Millar Thomson, LL.D., F.R.S., on "Crystallisation," and the second by Mr. James Swinburne, F.R.S., on "Science of some Toys."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 13...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Dr. W. Rosenhain, "Optical Glass." (Lecture III.)

Victoria Institute, Central Buildings, Westminster, S.W., 4.30 p.m. Professor A. S. Eddington, "The Movement of the Stars."

Engineers, Society of, 17, Victoria-street, S.W., 5.30 p.m. Annual General Meeting.

Surveyors' Institution, 12, Great George-street, S.W., 8 p.m. Mr. M. C. Duchesne, "English Timber during and after the War."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Colonel Sir Thomas Holdich, "The Work of the Peru-Bolivia Boundary Commission."

British Architects, Royal Institute of, 8, Conduit-street, W., 8 p.m.

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. F. E. Weston, "Hypo and its Uses."

Microscopical Society, 20, Hanover-square, W., 8 p.m. Mr. J. E. Barnard, "The Use of Ultra Violet Light in Microscopy."

Japan Society, 20, Hanover-square, W., 3.30 p.m. Mr. Yoshio Markino, "Just a few words on the Occasion of the Imperial Coronation."

Alpine Club, 23, Savile-row, W., 8.30 p.m.

East India Association, Caxton Hall, Westminster, S.W., 4.15 p.m. Mr. G. C. Whitworth, "Hindus and Muhammadans."

TUESDAY, DECEMBER 14...Sociological Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.15 p.m. Dr. L. P. Jacks, "A Drifting Civilisation."

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Professor J. T. Morris, "Recent Developments in Electric Incandescent Lamps in relation to Illuminating Engineering."

British Academy, in the Theatre, Burlington-gardens, W., 5.30 p.m. (Schweich Lectures.) Mons. E. Naville, "The Text of the Old Testament." (Lecture II.)

Asiatic Society, 22, Albemarle-street, W., 4 p.m. Sir C. Lyall, "Some Experiments in Adapting Arabian Metrical Forms to English Verse."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. (James Forrest Lecture.) Mr. H. M. Hobart, "Electrical Railways."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Professor A. E. Douglass, "Zodiacal Light and Counter Glow, and the Photography of Large Areas and Faint Contrasts."

Anthropological Institute, 50, Great Russell-street, W.C., 5 p.m. Mr. J. R. Moir, "The Evolution of the Earliest 'Chelles' Palæoliths from the Rostro-Carinate Implements."

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. The Hon. B. R. Wise, "Australia and the War."

Electrical Engineers, Institution of (Local Section), 17, Albert-square, Manchester, 7.30 p.m. Mr. J. R. Beard, "The Design of High-pressure Distribution Systems."

(Scottish Section.) Prince's-street Station Hotel, Edinburgh, 8 p.m. Mr. G. Wilkinson, "Electric Heating: Its Present Position and Future Developments."

WEDNESDAY, DECEMBER 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mons. Josef Denyn and Mr. W. W. Starmer, "Carillons and Carillon Playing."

Electrical Engineers, Institution of (Local Section), The University, Birmingham, 7 p.m. Mr. J. D. Morgan, "Notes on the Ignition of Explosive Gas Mixtures by Electric Sparks."

Meteorological Society, 70, Victoria-street, S.W., 7.30 p.m. 1. Mr. F. J. Brodie, "The Incidence of Bright Sunshine over the United Kingdom during the Thirty Years, 1881-1910." 2. Dr. W. Galloway, "Remarkable Cloud Phenomena." 3. Dr. J. R. Sutton, "South African Coast Temperatures."

Geological Society, Burlington House, W., 8 p.m.

Automobile Engineers, Institution of, at the Surveyors' Institution, 12, Great George-street, S.W., 8 p.m. Mr. F. W. Lanchester, "The Cylinder Cooling of Internal-combustion Engines, more especially as concerning Automobile Practice."

THURSDAY, DECEMBER 16...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. C. C. McLeod, "The Indian Jute Industry."

British Academy, in the Theatre, Burlington-Gardens, W., 5.30 p.m. (Schweich Lectures.) Mons. E. Naville, "The Text of the Old Testament." (Lecture III.)

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. 1. Miss Marietta Pallis, "The Structure and History of Plav: the floating fen of the delta of the Danube." 2. Mr. T. A. Dymes, "On the Seed-mass and Dispersal of *Helleborus fœtidus*, Linn." 3. The General Secretary, "Sample of 'Figured Ebony,' with specimens of walking-sticks manufactured from it by Messrs. Henry Howell and Co." 4. Mr. E. S. Goodrich, "On the Reproduction of *Protodrilus*."

Chemical Society, Burlington House, W., 8.30 p.m. 1. Messrs. W. A. Haward and T. Otagawa, "The Propagation of flame in mixtures of hydrogen and air. The 'uniform movement.'" 2. Messrs. P. C. Ray and R. De, "Molecular volumes of the hyponitrites of the alkali metals and metals of the alkaline earths."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. H. G. Theaker, "Composition."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Mr. J. R. Beard, "The Design of High-pressure Distribution Systems."

Historical Society, 22, Russell-square, W.C., 5 p.m. Miss C. A. J. Skeel, "The Influence of the Writings of Sir John Fortescue."

Geographical Society, Kensington-gore, S.W., 5 p.m. Mr. W. J. H. King, "The Nature and Formation of Sand Ripples and Dunes."

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 8 p.m. 1. Mr. E. A. Wraight, "Influence of Heat in Cyaniding Gold Ores." 2. Mr. A. W. Allen, "Clay: its relation to Ore Dressing and Cyaniding Operations." 3. Mr. E. Maxwell-Lefroy, "Wolframite Mining in the Tavoy District, Lower Burma."

Numismatic Society, 22, Albemarle-street, W., 6 p.m. Rev. E. A. Sydenham, "The Coinage of Nero."

FRIDAY, DECEMBER 17...Engineers and Shipbuilders, North-East Coast Institution of, Newcastle-on-Tyne, 7.30 p.m.

Mechanical Engineers, Institution of, Storey's-gate, Westminster, S.W., 6 p.m. Dr. R. Mullineux Walmsley and Mr. C. E. Larard, "Engineering Colleges and the War."

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FRIDAY, DECEMBER 17, 1915.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

CANTOR LECTURE.

On Monday afternoon, December 13th, DR. WALTER ROSENHAIN, F.R.S., delivered the third and final lecture of his course on "Optical Glass."

On the motion of the CHAIRMAN, a vote of thanks was accorded to DR. ROSENHAIN for his interesting course.

The lectures will be published in the *Journal* during the Christmas recess.

INDIAN SECTION.

Thursday afternoon, December 16th; SIR JOHN PRESCOTT HEWETT, G.C.S.I., C.I.E., in the chair. A paper on "The Indian Jute Industry" was read by MR. C. C. McLEOD, President of the London Jute Association.

The paper and discussion will be published in a subsequent number of the *Journal.*

OWEN JONES PRIZES FOR INDUSTRIAL DESIGN.

The Board of Education having decided to suspend the "National Competition," in connection with which the Owen Jones prizes have been awarded since 1878, that competition is no longer available as a basis for the award of these prizes in 1916.

The Council have therefore determined to suspend the offer of the prizes for next year, in the hope that after 1916 some suitable way may be found for carrying out the conditions of the Trust. These are that the interest on the capital amount available (£400) should be expended in prizes to "Students of Schools of Art who, in annual competition, produce the best designs for household furniture, carpets, wallpapers and hangings, damasks, chintzes, etc., regulated by the principles laid down by Owen Jones."

CENSORSHIP REGULATIONS.

The transmission of newspapers and other publications to neutral European countries has been forbidden by the Government, unless they are posted by authorised agents. The necessary authority for the postage of the Society's *Journal* has been secured, but occasional instances appear to occur in which the instructions of the Censor are not carried out by the officials, and the transmission of the *Journal* is interfered with.

Any Fellows residing abroad who find that their supply of the *Journal* has been irregular will understand the reason, and if they will communicate with the Secretary, he will be glad to supply any missing numbers.

CANTOR LECTURES ON "HOUSE BUILDING."

The Cantor Lectures on "House Building: Past and Present," by M. H. BAILLIE SCOTT, have been reprinted from the *Journal,* and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

A full list of the Cantor and Howard Lectures, which have been published separately and are still on sale, can also be obtained on application.

JUVENILE LECTURES.

Two of the Members of the Council—Professor John Millar Thomson, LL.D., F.R.S., and Mr. James Swinburne, F.R.S.—have kindly undertaken to deliver the Juvenile Lectures this year. Professor Thomson will give the first lecture on Wednesday afternoon, January 5th, at 3 p.m., his subject being "Crystallisation." Mr. James Swinburne will give the second on Wednesday, January 12th, at 3 p.m.; his subject will be "Science of some Toys." Both lectures will be very fully illustrated with experiments.

Special tickets are required for these lectures. They can be obtained on application to the Secretary.

A sufficient number of tickets to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to a ticket admitting two children and one adult. Fellows who desire tickets are requested to apply for them at once.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, November 30th, 1915; Sir Henry A. Blake, G.C.M.G., in the chair.

The Chairman, in opening the meeting, said it was his pleasant duty to introduce to the audience Sir Sydney Olivier, who was to read the paper that afternoon. Sir Sydney was in Jamaica as Colonial Secretary from 1900 to 1904, and as Governor from 1907 to 1913; therefore, curiously enough, he had had just about the same length of experience of Jamaica as he (the Chairman) had. England owed her possession of Jamaica—one of her oldest island colonies—to a disaster. In 1655 Cromwell sent out an expedition for the purpose of seizing San Domingo. The expedition, however, failed in its attempt, and was repulsed by a comparatively small body of Spaniards, who drove the English back to their ships under such circumstances that, when they arrived on board, either Penn or Venables broke the sword of one of the officers over his head. A doctor who wrote an account of the matter afterwards, said that if all the men who showed dire want of courage on that day had had their swords broken over their heads there would have been but few officers left. However, the expedition went to Jamaica, whose Governor happened to be ill at the time, and conquered it. That was the beginning of the English occupation of Jamaica, and from that time to the time with which Sir Sydney Olivier's paper dealt, the island had had various vicissitudes, but had happily emerged from them in the way which the meeting would appreciate after it had heard the paper.

The paper read was—

RECENT DEVELOPMENTS IN JAMAICA: INTERNAL AND EXTERNAL.

By Sir Sydney Olivier, K.C.M.G.,
late Governor of Jamaica.

The Island of Jamaica is the largest among the West Indian colonies, not excepting in any material sense that of British Guiana, if regard be had only to the settled area of that territory. It has the largest population. It is one of the oldest settled. Trinidad, the next largest of the islands, is, like British Guiana, an acquisition of the Napoleonic war period. Jamaica is the most English of all the large colonies, except Barbados; nothing could be more English than —perhaps I ought to say nothing so English as— Barbados. But Jamaica roads and fields are more English than the Barbadian. Trinidad and British Guiana are vastly different, both because of their double European colonisation and because so large a proportion of their introduced coloured population—and that a very progressive and prosperous element—is East Indian and not negro. Finally, Jamaica is much more important and significant in relation to the problem of mixed African and white communities than Barbados, because in Jamaica most of the black population own land and are free planters and jobbing labourers; the land of Barbados is still owned almost completely by white families in estates, and most Barbadian negroes are labourers for wages either at home or in the neighbouring islands or on the Isthmus.

Consequently, for anyone to whom the problem appeals as important, "What are the capacities of the Negroid races in fusion with white civilisation, and how can such a fate as that of Hayti be evaded in a transplanted negro community?" Jamaica, which is a going community in satisfactorily stable development, where there is neither oppression nor hostility between the two races, offers a very suggestive, if not, as I myself think, the most suggestive available example for study.

Jamaica as a community has a specific character of its own—it has an established life and temperament of society. The conditions are not the same as, for instance, those of the Southern States of America. Nor are the results or the promise of progress the same. But something has grown up, something has been brought about in the two and a half centuries of British Jamaican history, which have established a community predominantly negro, which does

in fact produce upon European and American visitors the impression of having an agreeable and not unpromising social personality.

I do not propose in this paper to say anything about the associations of Jamaica in history and romance. It was once reputed a very rich and prosperous island. Its wealth at that time rested on sugar production, with, for a certain period, a considerable contribution from coffee. The days of the monopoly of the West Indies in the supply of sugar and other tropical produce to English markets passed away long ago. Their passing, together with the abolition of slavery, undermined the ancient foundation of Jamaica's prosperity. Just about thirty years ago the progressive depression in the value of cane sugar had brought Jamaica to the most difficult and critical stage in its economic history. The development of Jamaica which I propose to talk of to-day falls within these last thirty years.

The island is a long fish-shaped stretch of land with mountains throughout the whole extent of its longer axis. The highest parts of this mountainous core, which emerge through more recent strata in the eastern part of the island as the Blue Mountain Chain, in the centre as the Bull Head Ridge, and again at the west end of the island, are composed of sedimentary rocks, partly of volcanic detritus, partly of clays and shales, some slightly carboniferous, some belonging to the lower cretaceous period. These formations are broken up by intrusive waves of granite and dykes of igneous rock. The ranges emerge or are exposed through the principal formation of the island, which consists of a white deep-sea limestone analogous to the chalk in England. This formation, which, when the island was deeply submerged, must have overspread the whole of it except the Blue Mountain Range in the east of the island, has been lifted up out of the sea at the east end of the island to an elevation of about 4,000 feet, and further west forms high table-land, lying from 3,000 down to 2,000 feet up, and broken away into lower foot-hills down to sea-level. This formation has been eaten out where it was thin and overlay or embraced ancient high ground, by rain and rivers, so that there is in the centre of the island a long interior basin exactly analogous to the interior basin of the Weald of Surrey, Sussex, and Kent, with limestone ranges surrounding it as the Downs surround the Weald. There are several other small interior basins, either completely enclosed or open at one end, in other parts of the island, and the rivers from the interior core of ancient mountains flow out through the limestone, through deep gorges, exactly as the rivers of the Weald flow out through the chalk, only, because the Jamaican limestone is at once harder in texture and more soluble in rainwater than the chalk, the gorges are steeper and deeper, and often the rivers have not succeeded in cutting a gorge, but simply burrow underneath and come out in the alluvial plains round the coast. The whole of the limestone formation is weathered into ridges, hummocks, and hollows (called cockpits), and is a mass of irregular surfaces.

The alluvial plains form the third chief division of Jamaica's geological formations. The largest of them are the plains in which Kingston, the present capital, and Spanish Town, the ancient capital, are situated. These extend from Kingston to beyond Old Harbour, a distance of about forty miles, and are on an average about seven miles in width, with deep indentations.

There is another large alluvial plain in the valley of the Plantain Garden River, running out at the east end of the island and draining the valley between the Blue Mountains and the southern range of the limestone; another, westwards, in the district of Vere, where the River Minho has spread out fertile detritus and silt from the interior basin. There is another about the Black River running far inland, and another in Westmoreland. There are smaller alluvial plains of the kind at Montego Bay, and in some places along the northern coast, though generally the northern coast is much steeper than the south, and the rivers run straight from the limestone into the sea.

Now, the ancient economy of Jamaica rested mainly on the cultivation of the alluvial plains, and other parts of the older geological formation, in sugar, combined with the feeding of working cattle.

The limestone formation produced coffee, pimento, annatto, and large quantities of oranges and other fruit; it also produced very fine grass for the breeding of cattle and horse kind. These breeding properties, called pens, are run as ranches for grazing only, and the production of pimento from trees growing in the pastures. There is practically no agriculture on them. All the old sugar estates having their works in the plains had what was called their "mountain" miles away in the limestone country. The slaves had their own provision grounds there—when they were past

work they went and settled there; freed slaves bought land and settled in the mountains; many colonies were planted by missionaries and others in the same districts. The land was not worth so much for sugar cultivation as the lowlands. It was much pleasanter for habitation, and much better suited for negro husbandry. It has two notable characteristics—first, it is waterless; over three-fifths of the island there are no streams except the rivers in deep gorges or underground, because every drop of rain that falls sinks into the surface immediately; and secondly, it is constantly covered with vegetation, because, not only is the rainfall generally good, but the moisture remains diffused in the limestone as in a sponge, and rises by capillary attraction to the roots of plants. As the African method of cultivation depends on the burning down of bush to produce potash for yams and other tuberous vegetables, this kind of ground suited the freed slave very well. But in severe droughts, when the rain-water tanks give out, the population suffers much from lack of water.

When the sugar estates went out of cultivation and employment failed, the plains became even less attractive to the labouring population than formerly, and for the estates which survived labour difficulties increased, because all who could get land and maintain themselves on the limestone sought to do so. What was happening thirty years ago was that the employment for labourers formerly given on sugar and coffee estates was coming to an end, and the great majority of the peasant landowners were settled in the limestone uplands, or in other interior mountainous parts of the country, such as those round the Bull Head and on each side of the Blue Mountain Range in St. Thomas and Portland, where there were both cheap land and a water supply; in these latter parts, however, settlement was not so convenient because the roads were bad. On the whole, the limestone was the most popular formation for the reasons I have given, and because it was easy to make roads and tracks about it.

But the mountain people depended for the earning of money on coffee, whose price had lately fallen, oranges for which the market was precarious, pimento and annatto for which the market was limited, and for food on their ground provisions, grown in the African manner. It was apparent that the agriculture of peasantry could be made much more productive, and that if it were not made more productive the population might with difficulty be kept alive in a poor way; but there could be no surplus available to pay for education, medical service, or the other requirements of a progressive civilised life.

The developments in Jamaica to which I must confine my attention to-day are those of its agricultural industry, its trade with the United States and this country, and its relations with Central America as a source of labour supply for the development of the countries adjoining the Caribbean Sea. I cannot even touch on the interior educational, social and political developments which have taken place during the last thirty years.

The two principal internal changes in the productive industry of the country—and it must be remembered that agriculture is its only productive industry, and that it has no minerals, no coal, and no manufactures—have been, firstly, the development of what may be called smallholders' agriculture, with the increase of what are classed in the island's returns as minor products, and, secondly, the development of the banana trade. The external development has been associated with the growth of the banana trade as between Jamaica and the United States, and in a less degree as between Jamaica and the United Kingdom; but it has, perhaps, been even more important in an indirect manner, not commonly taken account of, that is to say, through the colonisation of Central American countries, both in the construction of the Panama Canal, very largely made by Jamaican labour, and in the development of the fruit industry in Colombia, Panama, Costa Rica, almost entirely by Jamaican labour, and further in Nicaragua and Honduras to some extent by Jamaican labour.

Most people in England have principally heard of Jamaican developments in connection with the banana, so I will deal with that topic first. Jamaica is peculiarly well fitted by latitude and climate for the growth of bananas. It is sheltered by Cuba from the cold winds from the north, which affect that island and also the northern coast of Hayti. On the other hand, its atmosphere is less heavy, hot, and sodden than that of the Central American littoral. It is now full forty years, I think, since bananas were first shipped in small quantities to America. It is about thirty years since cargoes began to be taken from time to time in small sailing vessels. It is barely twenty years since the trade became considerable enough to occupy the energies of an important American corporation, then known as the Boston Fruit

Company, now merged in the United Fruit Company of America, which controls the whole fruit trade of the Eastern States and the Caribbean Sea.

It was Captain Baker, the founder of the Boston Fruit Company, who led the way in the demonstration of the cultivation of the banana on a large scale on abandoned sugar estates. His operations had begun by contracts with small growers in Portland, where there was rich soil and abundant rainfall in the valley of the Rio Grande. Finding this source of supply not fully reliable, Captain Baker and his associates began to take up abandoned sugar plantations in the alluvial flats of that river and also in the interior valley, south of the northern limestone range at the foot of the Blue Mountains, which had been similarly cultivated in sugar. Their example was followed first by one enterprising Jamaican landowner, and then on a smaller scale by others who occupied failing or abandoned sugar estates on the clays and alluvial lands accessible from the north side of the island. This development was favoured because the north side has a better rainfall than the south side, although the stretches of easy land available are much more extensive on the south.

Extensive cultivation was next taken up in the valley of the Plantain Garden River, which I have mentioned as running out at the south-east end of the island between the Blue Mountain Ridge and the southern Limestone Range. This is a splendid tract of alluvial land in which sugar estates still survived, and where at present prices of sugar large profits ought to be being made by a central factory serving the whole valley, which is capable of irrigation. Bananas and, with prudent foresight, coconuts were largely planted here by the Boston Fruit Company, a Jamaica Company and some private owners. Unfortunately this valley is open like a funnel to the east, and all heavy winds and hurricanes come to Jamaica from the east, so that though soil and climate are very suitable, banana-planting in this part of the island has had many losses to contend with.

Further west the rainfall on the south is insufficient for bananas; but in the great plain of the Rio Cobre delta about Spanish Town a fine system of irrigation was set up forty-five years ago by Sir John Peter Grant. This had not sufficed to keep the sugar estates in that district solvent, though when I first went to Jamaica there were still a few of them struggling on. At that same time the first experiments were being made in the planting of bananas on these irrigable lands. I remember well the discussions whether fruit so grown would be firm enough to travel. To cut a long story short, since that time the whole of the irrigable land in the delta suitable for the growth of bananas has been taken up and planted, and the demand for irrigation water has more than doubled, and now reaches the limit of the supply available.

Not all the land in these plains is suitable for banana-growing, because the plant requires good drainage and an easy root run; heavy clay is unfavourable to it; but the silty loam of modern river alluvium suits it excellently, provided the supply of vegetable mould which it requires is kept up. From that time onwards the cultivation has spread into new districts, and many old sugar estates in the valley of the Great River and the Montego River and its tributaries, which flow out at the west end of the island, have been put into extensive cultivation. There has thus been a very great revival of productive cultivation on former sugar estates which had been abandoned, and this has been carried on in the face of difficulties of labour supply, which have had to be met by the importation of Indian indentured labour. Whilst the revival of agriculture on a large scale has thus been effected through the cultivation of the banana on the old sugar estates, which, as I have mentioned, had ceased to be attractive places of residence for the labouring population of the island, there has, of course, been also a great increase in the production of bananas on the holdings of the peasantry in the mountains, both on the limestone and on those tertiary and granitic interior districts which I have mentioned as exposed by the denudation of the central core of the island. The peasant has, therefore, not only been withheld from furnishing a labour supply to the larger plantations by the fact that he did not like working or living there, but also by the fact that he had a very profitable alternative in growing bananas himself, although they do not grow so well on the limestone as they do upon the loams and silts.

Further, during the period of the depression in the sugar industry and the failure of employment at good wages which that depression brought about, the Jamaican negro had found well-paid work on the Panama Canal. I believe that about 25,000 Jamaicans were in employment under the French Company when that company suspended operations. Their

discharge and the return of many of them to Jamaica was a severe reverse.

After the United States Government took up the canal the emigration thither revived, and when I was in Jamaica there were between 40,000 and 50,000 Jamaicans in the canal zone. These men were earning 3*s*. 4*d*. to 4*s*. a day, whereas in Jamaica they would have been earning 1*s*. 6*d*. or perhaps 2*s*. In the meantime, Mr. Minor Keith, the builder of the Costa Rica railroad, had been struck with the promise of the diluvial slopes along the coast of Costa Rica. Costa Rica itself is a small Spanish republic occupying a table-land 5,000 feet up in the Cordillera Mountains. The coast of the republic is a long shelf of diluvium brought down by the torrents from these mountains and meeting the sea in a fringe of swamps and lagoons.

Mr. Minor Keith began to plant bananas. The soil was virgin; the method of cultivation the simplest; the underbush of the dense forest was cleared, the large trees girdled; the banana suckers were planted immediately. The large trees were then cut down and burnt, leaving only the castiloa rubber trees standing among the young bananas. These grew so rapidly as to keep down the weeds and bush about them, and very soon were yielding enormous bunches. When I visited Central America early in 1911, the United Fruit Company, which had incorporated Mr. Keith's company and the Boston Fruit Company, had 50,000 acres of land in Costa Rica. Most of this was in bananas, some in cocoa, and some parts were used for cattle. There was not a road on the whole sea coast; the only lines of traffic were the railway lines, which were owned or leased by the United Fruit Company, and the river beds. There were 40,000 Jamaicans working on these plantations as labourers, foremen, engineers, schoolmasters, clerks, and managers; a most efficiently organised industrial republic under the absolute, though very enlightened and benevolent despotism of the United Fruit Company.

This development of banana cultivation round the coasts of Central America, with American capital and Jamaican labour, is a really very remarkable feature, more especially when it is understood that the United Fruit Company, which has created this development, practically controls the whole trade and shipping facilities of all that sea and its coasts, and, in the districts where it cultivates, is to all intents and purposes the government of the country. The great demand for Jamaican labour in the industry thus organised has removed any difficulty in disposing of the surplus labour discharged from the canal works as they have approached completion. And it is on the basis of this colonisation that another very curious development in economic history has taken place.

Probably many of my hearers will remember that about fifteen years ago the Imperial Government gave a subsidy of £20,000 a year, combined with one of the same amount from the Colonial Government, to establish a steamer service, which was to run for ten years, direct between Jamaica and England, for the purpose of developing commerce and intercourse between this country and Jamaica on the basis of the banana trade. This undertaking was most energetically and public-spiritedly promoted by Sir Alfred Jones, on behalf of the Elder Dempster Company.

It is fair to pay this tribute to Sir Alfred Jones at the outset, notwithstanding that it may be said that the enterprise was a commercial venture. As a matter of fact it was not remunerative, and the results which it established, though important, were not at all the results intended and hoped for. Speaking broadly, beyond proving that bananas could be carried and find a market in England, which was an important result, it has not done very much for the Jamaica banana trade, and it has done very little permanently for any other department of the island's commerce. It did for a time something to develop interest in Jamaica as a tourist resort, but in that connection also it must be admitted to have failed to achieve anything like what was hoped for. Sir Henry Blake was the first Governor of Jamaica who took active steps to get the island's attractions as a health resort appreciated and made available. He worked hard both by policy and by literary effort to develop this side of her capabilities. No one who knows Jamaica will question the justification of his enthusiasm or that of Sir Alfred Jones in this cause. Sir Henry Blake organised the Jamaica Exhibition of 1891, and in connection with this effort promoted the building of hotels to accommodate visitors. Sir Alfred Jones leased or bought the hotels from the Government and did his best to provide comfortable passenger steamers to carry visitors. I think what has baffled these efforts, so far as this country is concerned, is that the journey takes rather too much time out of a winter holiday for people who do not enjoy spending their time on board ship. It is also

a little expensive, and Jamaica hotel-keepers and lodging-house keepers charge a great deal, according to English ideas, for very indifferent hospitality. On the other hand, there has been, in certain seasons, a pretty large influx of American visitors, and a certain number of Canadians. The trip from New York for a winter holiday, with a fortnight in the island, is a very easy and pleasant one. A certain number of Americans have even built winter villas in Jamaica. This traffic, I think, will increase, and Sir Henry Blake's belief in its possibility be progressively justified. It is curious to remember that thirty years ago Jamaica was generally thought of in this country as having a deadly climate. It is really a peculiarly healthy place for people of regular lives.

To return, however, to the commercial aspect of Sir Alfred Jones's banana service. It started badly. The supplies of fruit from the larger estates were, to a great extent, controlled by the United Fruit Company; the men who were sent out to buy fruit and load the vessels, being new to Jamaica, did not thoroughly understand the business, and the first shipments of the fruit did not travel well. In order to save the enterprise Sir Alfred Jones entered into partnership with the United Fruit Company, whose employees were experts in the trade, and arranged for them to load the Elder Dempster steamers. This work was managed by a subsidiary company known as Elders and Fyffes. The share capital was increased, and nearly half but not quite half of the shares of the company were allotted to the United Fruit Company, Sir Alfred Jones thus maintaining control. In the autumn of 1903, when the service had been in operation for about eighteen months, a hurricane destroyed the Jamaica banana fields, and there was no Jamaica fruit for many months. In order to fill the ships, both those of the Direct Line and also additional vessels which Elders and Fyffes had built, the whole fleet was sent to Costa Rica to be loaded by the United Fruit Company from their plantations there. Thus the Jamaica banana, so reputed, became the Costa Rica banana, a somewhat larger and more insipid fruit, and the Costa Rica banana to this day it predominantly remains, because while the Costa Rica trade from the United Fruit Company's plantations has greatly increased the Jamaica trade has not increased in proportion. This is partly explained by the fact that a later development in the affairs of the Elders and Fyffes Company was brought about by the United Fruit Company acquiring additional shares in the former and thus obtaining control of its operations, which enabled them both to put pressure upon Elder Dempster and Co. in regard to rates of freight and thus diminish the profits of the Direct Line, and also to govern their relations with the planters of Jamaica in the interests of the American Corporation rather than in that of the British Colony. The Elder Dempster line has now ceased to serve Jamaica; but Elders and Fyffes have a very fine fleet of fruit steamers bringing United Fruit Company's fruit to England, principally from Costa Rica and Santa Marta in Colombia. Some Jamaica fruit, bananas, grape fruit and oranges, is carried, but in the year 1914 the total value of fruit sent from Jamaica to this country was only one-tenth of the value of the fruit sent from Jamaica to the United States, that is to say, £135,000 to this country as against £1,350,000 to the United States. This, however, I am glad to observe, is the highest amount yet reached by this trade to this country, which had in the twelve previous years since the Direct Line started only averaged £83,500 a year, little more than twice the amount of the Direct Line subsidy. So far as a market is concerned, Jamaica could sell the whole of her fruit to the United States, and the existing facilities for sending it to England do not give and never have given her a buyer competing with the United Fruit Company, as it was intended they should.

A measure of the importance of the development of the banana industry in Jamaican agriculture is given by the Blue-book returns of cultivation. In the year 1885 the agricultural returns give no statement of land planted in bananas. That does not mean that bananas were not grown, but that they were not grown separately in large arable fields as now, but mixed up with coffee, cocoa, ground provisions and other cultivation on small holdings or in small patches.

In 1895 the acreage planted is shown as 18,528. In 1905, 44,325; in 1915, 85,854—doubling itself, as you see, every ten years. It is interesting at the same time to note the figures of the cultivation of coconuts. In 1905 the acreage of coconut plantations, which are additional to great numbers of coconut trees grown scattered about the island, was 10,395. In 1905 it was 8,561, which means that in 1903 a great many coconut plantations were blown down by the hurricane. But on the whole the

hurricane of 1903 taught Jamaican planters that coconuts and cacao were a more reliable standby than bananas in windy places, and in 1915 the acreage planted in coconuts was 29,731, about three and a half times as much as ten years before. In the same period cacao or chocolate had increased from 4,628 acres to 11,088 acres, which is very much less still than it ought to be upon an island like Jamaica.

Looking back at the cane-sugar industry during the same period, the acreage in 1885 was 40,425; in 1895, 31,284; in 1905, 23,871; and in 1915, 31,727, showing a recovery, which has been due to the greater stability of the industry under the effect of the Brussels Convention, to the erection of some new central factories, and the consequent extension both of estate planting and cane farming.

It might be thought that with the present prices of sugar this industry would further revive in Jamaica, and I have no doubt that there will be shown a substantial increase in the acreage of cane cultivation so long as the present prices last. But there is no possibility in Jamaica of a re-establishment of the sugar industry in the position it once occupied as the basis of the island's economy, because the districts in which sugar can be grown and manufactured under the conditions now required for profitable sugar-making are of limited extent. As I have said, perhaps the best available area is the Plantain Garden River valley, but that is now largely planted with coconuts and bananas. The district of Vere could produce much more sugar if it were irrigated. Unfortunately one irrigation scheme has proved a failure, as the springs which fed it have never yielded a full supply since the earthquake of 1907, and another irrigation scheme now in process of development is being carried out under considerable financial difficulties. The well-watered plain of Westmoreland, favoured by rainfall, has maintained a considerable number of sugar estates in cultivation, and there is still some room for revival and extension here. There is no other large area suitable in Jamaica for sugar production on the modern system.

One change in the pastoral economy of Jamaica may be mentioned in connection with the banana industry. Jamaica used to be a horse-breeding country and produced a good deal of very good stock. The development of the banana industry has created a very brisk and paying demand for mules. The result of this demand has been progressively and now almost entirely to destroy the breeding of good horses, whilst, owing to the reduction in the number of good-sized mares that is resulting, the production of large mules is becoming more and more difficult. At the same time motor locomotion, and to some extent motor traction, are replacing buggies and waggons on the roads.

The profitable results of the development of the banana trade, the improvement of native agriculture and the large amount of money earned by Jamaica labourers on the Panama Canal and on banana plantations in Central America, have reacted in a marked degree upon internal conditions. First of all, the banana industry gave a number of small landowners, black and coloured, the opportunity of making good money. The old sugar industry had supported the planting class in comfort and had enabled them to build good houses and to take a pride in their establishments. With the decay of the sugar industry the general level of what might be called the middle-class civilisation in the island declined. The banana industry gave an opening for a revival and for the emergence of a class of well-to-do small planter, such as was supplied, to some extent, in former times by the coffee industry when coffee had a paying price. As a result, all over the country now, but especially in the prosperous banana districts of St. Mary's and Portland parishes, you can see good new houses, pretty gardens and smart turn-outs. To a certain extent, men returning from Panama with earnings swell this class. Another very noticeable feature is the improvement of peasants' houses. This has been effected principally through the improvement of local agriculture, largely the work of the agricultural societies, and also directly by what is known as the "Prize Holdings" scheme, under which the Government through the agricultural society gives prizes for the best-kept holdings, giving marks for all the desirable qualities of cultivation, live stock, buildings, fences, etc.

The policy of the Jamaica Government in regard to the economy of the peasants' life is now fairly settled and understood, so that I hope that even changes of Governors and cataclysms of finance may not permanently interfere with its development. It rests upon improvement in agricultural methods and the making and maintenance of roads, to enable produce to be brought out to market.

The fundamental idea in the agricultural education which the island requires is the substitution of mixed agriculture, employing and maintaining live stock, both for food supply

and to produce manure, in supersession of the mere growing of vegetables by the use of natural potash and humus. The principal organ of this education has been the Jamaica Agricultural Society, which was founded by Sir Henry Blake, and on whose success he may truly congratulate himself, and which has now, I believe, upwards of 100 branch societies distributed all over the island.

Jamaica, whilst it was a country of large estates, was already celebrated for the horses it bred, largely from thoroughbred imported stock. Its population being English and negro, it was a country where horse-racing was and is very popular. It was also a fine country for cattle raising, and being colonised by Englishmen and Scotsmen it knew what good beef is, and trouble had been taken to produce it. But until within the period I am speaking of the British use of live stock in agriculture had been quite outside the ideas of the peasant proprietor. He often had a horse, a mule, or a donkey, but that was for purposes of transport. He sometimes had a wretched skinny pig and a few goats or inferior fowls; but it was not until the Agricultural Society and its branches developed their work that the agricultural shows of the island began to be used as a means of encouraging good stock among the small settlers, as well as on the large pens, and the improvement of the preparation and marketing of their coffee, cocoa, and minor products.

The measure of the development of native agriculture is shown in the remarkable increase in the exports of what used to be called minor products; but this development is perhaps most remarkable, not in its material outcome, but in its social and intellectual aspects, which can best be recognised by studying the operations and activity of the Agricultural Department and the Agricultural Society now and their acceptance among the population as compared with what was the case thirty years ago.

When the Government began the work of agricultural education, by means of the activities of its instructors and through the Agricultural Society, the attitude of the negro cultivator generally towards these efforts was, for the most part, precisely the same as is the attitude of the average British farmer of to-day towards any suggestion that he might improve his methods of food production. As regards the ideas of cultivation, pruning and preparation of products which the Government sought to diffuse, they were all "buckra foolishness," and the native cultivator had no need to be taught his business. As regards a good deal of his own agriculture that was probably true. The Jamaica peasant is very skilled in knowing just where and how yams and cocoes may best be cultivated, but as regards new products and new methods he was very sceptical and conservative. In another aspect, the activities of the instructors were suspected of being merely a pretext for spying out what property the peasant had, in order that he might be taxed on it—which I am told is very much the attitude of the British farmer to-day towards any attempts on the part of the Board of Agriculture and Fisheries to improve our statistics of cultivation and stock. We are only allowed to collect them under promise of absolute secrecy.

For all agriculturists it would seem experience is the only convincing process, and I attribute the first beginnings of acceptance for the idea of improvements in agriculture in Jamaica to the stealing of the eggs of improved breeds of fowls. But now there are established, as I have said, about the island, more than 100 branch agricultural societies, which meet and discuss and take in the agricultural journal, and attend demonstrations and lectures with a real and intelligent interest. This organisation is now living and growing of its own vitality, and because it is doing this and is now a democratic and not a bureaucratic structure, it is one of the most interesting features in modern Jamaica. One of the greatest curses of Jamaican agriculture is what is called "prædial larceny"—that is to say, the stealing of growing crops and the raiding of provision grounds. Public opinion never used to be sympathetic towards the efforts of the police to deal with this evil, and nothing seemed to affect it. About fifteen years ago I had an idea as to how it might be dealt with, and about eight years later I managed to get it put into operation. Most people in any district knew who were the thieves, but they would not inform against them. I took the agricultural societies, which were then beginning to increase in popularity, as bodies of men who had an interest in cultivation and in self-protection, and I got a law passed giving any agricultural society the power to appoint certain persons who might arrest at sight any person found in possession of produce which there was reasonable suspicion that he had no right to be carrying. This would have been a dangerous power to give to the police, but it was safe to give it to representatives of the class who knew very well who were growing crops and

who were not, and the thing has worked well. I see now in the Jamaica agricultural journal frequent references to the subject of the selection of these "authorised persons" and to their activities, showing that the institution is becoming a recognised organ of mutual protection, and that the organised public opinion represented by the agricultural societies is now turned against prædial larceny. This is really a new condition of things, and I believe may do more than any of the other methods which have been advocated to repress and, as far as possible, extinguish it.

It is an unsatisfactory fact that the problem of labour supply for extensive and continuous agriculture remains very difficult in Jamaica. This results naturally from the advantages of independent peasant life, the increased interest in the peasant system of agriculture, and the fact that if a man wants to work at wages he can earn very much more at Colon or in Costa Rica. The maintenance of banana plantations or sugar estates demands a continuity of labour which it is almost impossible to obtain from creoles, and I do not see how it is ever going to be possible. Hitherto, the necessary proportion of continuous labour, for only a proportion is required, has been furnished by coolie immigration. This has been suspended for the last two years, and the prospects of its resumption seem remote.

Reviewing the foregoing brief summary, two things principally strike me. First, that there has been a revival and development of agriculture and the resulting trade in Jamaica, illustrated in the figures of exports, which in 1885 were valued at £1,484,000 and in 1915 at £2,905,000—practically a doubling—and that this development has been produced on the two different lines I have spoken of. Money has been made. Millions of pounds of profit have been made out of bananas in Jamaica and Central America, and a great deal of money has been made by her people in wages in that cultivation; but almost all of that development has been effected and almost all the profits enjoyed, not by Englishmen, but by Americans. Some Englishmen, or perhaps I should say some Scotsmen, have indeed done well, but their interests are small as compared with the interests of the United Fruit Company. I always regret that this work should have been done by Americans and not by English, and am bound to say that the reason is that, whilst the Americans had the advantage of the control of a near market, it is also the fact that they have shown greater enterprise and capacity. Secondly, there has been a considerable internal development, and this has been done by English methods of stimulus. I hope Sir Henry Blake, who can claim a great deal of the credit for such stimulus, will not insist that I shall call them Irish methods, although I am bound to say that that kind of development work has been much more effectually exhibited in Ireland than has been yet in England. The development of the banana industry has been the development of a capitalised industry by very capable direction and organisation. The development of the internal agriculture has been brought about by a stimulus to the intelligence and aspirations of the common folk of the island; the schoolmasters in the elementary schools have been brought into it; it is bound up with the popular organisation of the agricultural societies and the parish councils. It is very, very far as yet from having taken the hold of the people which it should yet do; but it has so far taken hold of them as to justify the assertion that this movement has now thoroughly established itself as a vital force in every part of the island, and is already showing substantial material results.

DISCUSSION.

The Chairman (Sir Henry A. Blake, G.C.M.G.) said the author had given a very interesting account of the development of Jamaica, especially in regard to its agricultural side. From investigations he had made, he found that in 1897, the year before he left Jamaica, there were 663,000 acres of land in cultivation, whereas in 1914 there were 940,000 acres in cultivation, an increase of 42 per cent., due to the activities of the Agricultural Board. He wished to congratulate the author on his description of Costa Rica as "a most efficiently organised industrial republic under the absolute though very enlightened and benevolent despotism of the United Fruit Company." To his mind that was a very satisfactory description of a good progressive republic, and he thought England would be all the better if it had a "benevolent despotism" to govern it. The establishment of the Agricultural Department in Jamaica had had a great deal to do with its development, but it would have been of little use if the island had not had the means of development, *i.e.*, the means of communication. After the very successful Jamaica Exhibition of 1891, there was a considerable surplus in the revenue, and the problem then arose as to whether it would be better to use that surplus to relieve taxation or to lay it by as a reserve. Many people in England thought it would be more prudent to keep it as a reserve to be utilised in the event of

bad years in the future. Personally he thought that the proper course to adopt was to spend the money in the development of the country, so that if a bad year came there would at least be a possibility of recovering from it. Therefore, during the nine years that he spent in Jamaica, 1,000 miles of roads, 22½ miles of bridges, and 197 miles of railways were built. The result of that was that fruit grown at a distance from the seashore could always be brought to the coast without being stopped by the flooding of rivers, which sometimes became impassable in a few hours and remained in that condition for many days, so that when there were no bridges, steamers coming for cargoes of bananas or other produce might be kept waiting for a long time at great expense. Sir Alfred Jones had done a great deal to develop the banana trade in Jamaica, but one of the reasons why he was only partially successful was that he had to take his bananas from small growers as well as from some of the large growers. Many of those people grew their fruit under different conditions, so that it ripened at different times, with the result that when Sir Alfred Jones obtained a cargo of it he could never be certain that some of it would not go bad before it arrived in England. It therefore had to be taken to England *viâ* New York, and some of it disposed of there. Had Sir Alfred Jones lived, it would be possible for him at the present time to obtain an entire cargo of bananas from two or three large estates, all grown under similar conditions and ripening at the same time, under which circumstances he was sure he would have made a success of Jamaica bananas as a cargo for England. A great deal had been done with regard to the educational work of the island. Educational work in Jamaica practically began in 1834. In 1666 Jane Mico, of London, widow of Sir Samuel Mico, left £1,000 to be invested for the purpose of assisting poor slaves. In about 115 years that £1,000 became £120,000, and was devoted to educational work in the West Indies. In 1834 the Mico Training College was founded in Hanover Street, Kingston, from a grant made from this fund. These premises were acquired by Government. A new college for the training of teachers was built on an excellent site and was opened in 1894. It had attached to it a fully equipped workshop and a school garden. In 1896 a technical school was established in Kingston, and there were branches of it now in every part of Jamaica. The author had shown that Jamaica had developed, and was still developing very satisfactorily. About fifty-three years ago there were 93,000 small-holders, while at the present time there were 184,000. Fifteen years ago only about 40 per cent. of the population could read and write, whereas now 55 per cent. could do so, so that education had advanced considerably in the island. He did not think the future of Jamaica depended entirely upon sugar or bananas. Sugar cultivation might be improved in the future; but he thought the Government at home might greatly assist the West Indian colonies by treating them with a little more consideration than they had hitherto shown. They had placed upon West Indian rum an additional duty of 4*d*. per gallon, which was a very serious and, in his opinion, unfair additional duty, and pressed very hardly upon the sugar industry of the islands. He had tried to introduce the cultivation of cassava, a preparation of which was called, along the South American coast, "farina"—farina being to South America what the potato was to Ireland, used by everybody at every meal. There was no part of Jamaica where it could not be grown; but it was always very difficult to get agriculturists—white or black—to start any new cultivation, and he was not very successful in his attempt. He did not think the author was correct in saying that there were no minerals in Jamaica, for there was a great deal of copper there. It had been mined at one time in the Blue Mountains, and possibly might be mined there again if the communications from the Blue Mountains were less difficult, and when last in Jamaica he had seen a large body of copper being mined in Clarendon. Continuous labour was necessary for the successful cultivation of sugar, and he was therefore sorry that the employment of coolies in Jamaica had been discontinued, for the Jamaican peasants were often busy with their own crops when they were required on the sugar plantations, therefore the labour on those plantations became intermittent. The coolies were very happy and contented in Jamaica, and took a great deal of money with them whenever they returned home. He had himself seen a man who came out as a coolie about twenty-five years ago, and who now had a large property in the west of Jamaica. It should not be forgotten what Jamaica and other West Indian colonies were doing for England with regard to the present war. The Bahamas and other small islands could not supply a sufficient number of men to form a unit of their own, so they sent their recruits to Jamaica to combine with the contingent there. English people had cause to be proud when they remembered how the whole of the British Empire had risen with one accord to declare that might should not prevail over right. When the war was over he thought the time would come when the Government at home would have to provide some means by which the different parts of the British Empire in the north and south and east and west should have some voice in reference to Imperial questions.

Sir Daniel Morris, K.C.M.G., D.C.L., expressed his appreciation of the great interest the author and the Chairman had shown in Jamaica, and the very valuable services they had rendered to that country by their speeches

on the present occasion. Jamaica was to be congratulated on having two active past Governors to lay before the people at home their views with regard to the wonderful developments that had taken place in that island. It seemed a striking fact that the revenue of Jamaica had so largely increased in recent years, that the Government was in a position to extend further the various industries and to increase grants for education and other purposes in order to uplift the whole mass of the population of the island. The author had been connected with Jamaica in various capacities. He (the speaker) went there with him in 1898 on a Royal Commission, which led to a considerable amount of interest being taken in the West Indies and also to grants being made for various industries, which had since developed to a very large extent. The author afterwards went out as Colonial Secretary, and, after the terrible earthquake in Jamaica, he was appointed Governor. From his intimate knowledge of the author's work, he thought the latter could look back with pride on the services he had rendered to the island. The Chairman also had taken a keen interest in Jamaica. He (the speaker) was in the island when Sir Henry organised, in 1891, the splendid exhibition, to which products and specimens from all parts of the West Indies were brought and exhibited for the edification and instruction of visitors from England as well as from the United States, and at the opening of which the present King, then Prince George, was present. After the exhibition he had an opportunity of discussing with Sir Henry the best way of extending knowledge of agricultural matters amongst the people of Jamaica. Later Sir Henry started the Agricultural Society, which had done an immense amount of good. With regard to the efforts of Sir Alfred Jones, one of his chief difficulties was that when, according to the terms of his contract, he wanted to buy bananas he could not get them, because nearly all the large growers were already under contract to supply their fruit to the United Fruit Company, and however much the growers might wish to support and encourage Sir Alfred Jones's efforts they could not do so. He remembered that the first paper he read about Jamaica to an English audience was so long ago as 1883, when he touched particularly upon the possibilities of agricultural development. Since then the West Indies as a whole had made great progress. The late Mr. Joseph Chamberlain, who appointed the Royal Commission of 1898, and obtained funds from Parliament for the Imperial Department of Agriculture and for steamship services, was very pleased to hear, a few weeks before he died, that the total revenue of the West Indies had nearly doubled and the total trade had increased from £16,000,000 to something like £26,000,000. In concluding his brief remarks he was sure the people of Jamaica would rejoice to read what had been said that afternoon, and would feel that they had friends at home who were prepared to do a great deal to help them.

Mr. Edward R. Davson agreed with all the remarks the Chairman had made upon the paper. He was very much struck by the author's statement that the greater part of the profits on the development of Jamaica were going into the pockets of the Americans rather than of the English. One could not feel that Jamaica was in any way to blame for that, because she naturally wished to develop her trade in the most easy and profitable direction; but, at the same time, it seemed a pity that an old English colony like Jamaica should find it more to her interest to trade with America than with England. The solution of the difficulty might be along the lines which the Chairman had indicated. It was impossible to speculate what was going to happen after the war, when economic conditions would be very different, yet he thought English people were already beginning to feel that they could not treat Jamaica, or any other colonies that had stinted and economised in order to supply money and goods to England, and that had sent their sons—white and brown and black—to take their places in the fighting line, on the same plane as those foreign countries whose one idea in the past had been hatred towards England, and whose one idea at present was to wipe Englishmen off the face of the earth. It had been his privilege on the previous day to see some of the troops of the West Indian contingent, amongst whom there were several hundred Jamaica men, and he could not help feeling—when he saw those men of Jamaica and Trinidad and British Guiana and other West Indian islands over here, not as visitors or strangers, but as men in khaki, who were prepared to do and, if necessary, die for England, and who were as much British as any British regiment—that it was impossible in the future for England to treat the countries from which those men came with the same indifference as she had sometimes treated them in the past.

Sir Evan James, K.C.I.E., C.S.I., proposed a hearty vote of thanks to the author for his most valuable and interesting paper. He himself was the great-great-grandson of one who owned a valuable sugar estate in Jamaica, which only passed from his family recently, and he had been to that island several times, both when the author and Chairman were there. Many years ago Lord Macaulay, when writing about Lord Metcalfe, who was Governor of Jamaica and afterwards Governor-General of India, said that Jamaica was the second jewel in the crown of England—India, of course, being the first. He thought Jamaica was to be congratulated on having two such Governors as the author and Chairman to stimulate its agricultural progress. Having regard to the persistent hurricanes which con-

tinually blew down bananas and cocoa-trees in Jamaica, he thought the island should trust once more to her magnificent breeds of oxen, horses, and mules. The mules especially should be of value during the present war. He was sure he would be expressing the feeling of the meeting in thanking both the author and the Chairman.

MR. BYRON BRENAN, C.M.G., seconded the resolution, which was carried unanimously.

SIR SYDNEY OLIVIER, K.C.M.G., in reply, said it had given him great pleasure to see Sir Henry Blake in the chair that afternoon. He did not think people in England quite realised what the West Indies were doing in regard to the war. As soon as war broke out nearly every young man in Jamaica who could by any possibility come away, joined the Army, either as an officer or private. The West Indies were sending home a contingent of 3,000 men and were also maintaining a reserve of 3,000, so that they now had practically 6,000 under training. The people of Jamaica were anxious to do more than that, and had sent home many gifts of money and tobacco and fruit. It was a source of pride to him to be associated personally with the West Indies, and to know what they were doing to help England in the war. He would like to make an appeal to the meeting on behalf of the West Indian Contingent Comforts Committee, of which Mr. Aspinall was the secretary, as the calls on the funds of the Committee were very much greater than had at first been expected.

FIFTH ORDINARY MEETING.

Wednesday, December 15th, 1915; W. G. McNAUGHT, Mus.Doc., F.R.A.M., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Haddon, Walter, 132, Salisbury-square, E.C.
Henderson, Lucius J., 10, Fauenil-place, New Rochelle, New York, U.S.A.
Howell, Hon. Clark, Atlanta, Georgia, U.S.A.
Lal, Lala Mohan, B.A., Gulshan Villa, Simla, India.
Phillips, J. S. M., Merchant's Bank, Pittsburgh, Pennsylvania, U.S.A.
Robbins, Rowland Richard, J.P., Holly Croft, Sipson, Middlesex.
Wooldridge, Charles L., Fulton Building, Pittsburgh, Pennsylvania, U.S.A.

The following candidates were balloted for and duly elected Fellows of the Society:—

Fakira, Meherali Mahomed, 13, Esplanade-road, Bombay, India.
Lyster, Anthony George, M.Eng., M.Inst.C.E., 2, Queen Anne's-gate, S.W.
Phelps, William Heath, J.P., Park House, 13, Park-street, Calcutta, India.
Stewart, William Arnold, Bulak Technical School, Cairo, Egypt.

THE CHAIRMAN, in introducing the authors, said the Society was privileged that evening to listen to two of the most distinguished experts living on the science of bell-making and the art of bell-playing. He had often listened with great awe to Mr. Starmer's exposition on bells, and M. Denyn was distinguished throughout the world as an artist in bell-playing—not merely as a bell-ringer but as a great artist. A good deal was heard about bell-playing in this country, but the British people had very little conception of the development of the art that had taken place in Belgium, where people came in thousands to listen to the recitals of sonatas, overtures, etc., by distinguished players. The proceedings that afternoon were very much like the play of "Hamlet" with the chief character absent, because it was, of course, impossible to mobilise within the building ten tons of bells; but no doubt the papers would lead the audience to desire to learn more upon the subject, and pursue the matter further.

The papers read were—

TECHNIQUE ET MÉCANISMES DE CARILLON.

Par JOSEF DENYN,
Carillonneur de Malines, Belgique.

Mesdames, Monsieur le Chairman, Messieurs,—

Demandé par la commission de votre honorable société à donner lecture au sujet de la technique et des mécanismes de carillon, j'ai eu un moment d'hésitation à accepter une invitation aussi flatteuse. Je crois, en effet, à la difficulté de me faire comprendre dans les explications des détails d'un instrument cependant si connu et si apprécié de nos jours. Il se pourrait aussi que le conférencier ne soit point toujours à la hauteur du technicien. Pour ces raisons j'ai à solliciter votre bienveillante indulgence.

Le jeu du carillon a été dès son origine un jeu populaire, incarnant dans nos contrées le décorum des fêtes publiques. Il consistait la plupart du temps en la performance d'airs simples et connus. Plus d'un carillonneur y excellait; il en fut même qui étonnèrent par leur montre de virtuosité. C'était, cependant, à de rares exceptions près, la limite de leur art. Il n'y avait pas de pathétique dans ce martelage du fer sur le bronze sonore. L'évolution dans ces performances a pris naissance il y a quelques quarante ans. Par suite de certains perfectionnements apportés aux détails des connections, tout en maintenant le principe du vieux système à clavier, il nous a été permis d'innover un autre genre de jeu. Pour en arriver à vous le faire comprendre, il est très utile d'établir, tout d'abord, ce qui est nécessaire à former une bonne installation; ensuite, ce qui est inhérent

à l'exécution d'une artistique performance. Dans cet ensemble nous trouvons comme facteurs: (1) la tour avec la chambre des cloches; (2) le beffroi de suspension et les cloches; (3) leur emplacement; (4) les mécanismes et connections; (5) la méthode de jeu; (6) la composition du programme de concert.

Quand une administration communale ou autre décide la restauration ou la construction d'une tour, elle en réfère à l'architecte pour la formation des plans. La tour se construit ou se restaure en conséquence. Du carillon qu'on projette, il n'est point ou peu question pour le moment. Cela se fera et s'arrangera plus tard! Quoique irrationnelle, c'est en général la manière de procéder. Grave erreur! Il arrive encore pour la restauration des tours que l'architecte tienne à son plan primitif. Or, les beffrois de construction antérieure aux carillons étaient souvent disposés en concordance d'un simple emplacement de cloche d'alarme ou de triomphe; ne possédaient point toujours les aménagements conformes aux exigences requises pour une bonne suspension de cloches ou un emplacement régulier de connections. Comme exemple, en ces derniers temps, je puis vous citer la restauration du beffroi de Gand (Belgique). Belle construction s'il en fut! On y disposait du nécessaire à parachever une installation modèle. Les cloches portaient l'inscription du roi des fondeurs du dix-septième siècle: *Hemony*. Vous détailler tous les défauts de cette installation m'entrainerait trop loin. Il suffira de vous signaler que le plancher de la chambre des cloches se trouve à trente mètres du sol, alors qu'à Malines il atteint soixante et quinze mètres de hauteur. La superficie des ouvertures de la même chambre y mesure trente-six mètres carrés; à Malines cent quatre vingts environ. Les gros bourdons sont à l'étage supérieur, là où devrait se trouver le carillon même. En vue du but à atteindre je puis affirmer que le résultat fut négatif. Avant d'établir définitivement les plans il convient donc que l'architecte visite une installation modèle; qu'il consulte le carillonneur expert. Celui-ci lui dira:—Que le carillon, selon son importance, selon les bâtiments avoisinants, selon les atours de la contrée, devra se placer de quarante à soixante-et-quinze mètres de hauteur. Que la chambre des cloches sera carrée de préférence. Si octogone ou autre, comparativement plus large (ce pour le placement conforme de toutes les connections). Qu'elle aura des ouvertures spacieuses de chaque côté de la tour (ce pour le dégagement régulier de toutes les ondes sonores). Si je vous dis spacieuses, je détermine que ces ouvertures doivent avoir, principalement en hauteur, les dimensions proportionnelles à celles du beffroi de suspension des cloches.

Le beffroi de suspension se compose d'un enchevêtrement de poutres auxquelles on attache les cloches. Il sera en bois de chêne. Le bois, à l'encontre du fer, isole le son. Aux soutènements des côtés, les poutres seront superposées et alignées dans une même direction. L'espace intermédiaire sera réglé par la dimension des cloches à y suspendre. Ce beffroi doit être construit selon les règles de l'art, trouvant sa résistance dans la solidité même de la construction; n'ayant aucune attache, nul soutien aux maçonneries de la tour. Les poutres seront de dimensions suffisantes pour maintenir, au martelage des cloches, leur complète rigidité, et assurer ainsi la prédominance de tout l'ensemble de la construction sur le poids des cloches à y suspendre. Ce beffroi sera placé au beau milieu de la chambre. Il en résulte que le tout groupé à l'intérieur laisse un espace de dégagement disponible qui *isolera* les cloches des ouvertures de la tour. On pourra m'objecter que je néglige le côté esthétique; par contre, je m'assure d'une chose capitale: la bonne *acoustique*.

Il n'entre point dans mes intentions de vous parler des cloches de carillon. Je tiens cependant à constater que pour leur fabrication l'emploi des matières premières de qualité supérieure est indispensable, la parfaite consonnance étant une condition *sine qua non* de réussite. On exclue absolument une cloche dissonante, parce qu'elle est mauvaise de nature. Dans l'ensemble elle resterait toujours une tache, à laquelle ne saurait obvier le meilleur accordage. Me basant sur les modèles des vieux fondeurs, Hemony et Van den Gheyn, je puis affirmer que l'étendue du registre d'un carillon se limite à quatre octaves. La grosse cloche pèsera approximativement de huit mille cinq cents à neuf mille kilos. Des poids supérieurs ne vous donnent plus ces tonalités claires et déterminées qui en doivent former la base. Le poids de la plus petite ne saurait être inférieur à huit ou neuf kilos sans tomber dans le domaine des sonnettes, dont la tonalité fluette et grêle manque de sonorité, de consistance, et serait de mauvais contraste.

Les cloches, ayant des attaches très rigides, seront suspendues aux poutres superposées et symétriquement alignées. L'emplacement sera en concordance de leur suite de tonalités chromatiques régulières, à commencer par les plus petites aux poutres supérieures,

L'espace réservé entre la cloche et la poutre inférieure sera suffisant pour assurer non seulement le jeu facile des battants mais aussi le placement conforme de tous les mécanismes des connections. Aux côtés du beffroi de suspension on trouvera la place nécessaire à caser quatre cloches de dimensions respectables. Tout l'ensemble de cette construction, faisant bloc homogène, sera surmonté d'une plate-forme, à moins que les dispositions spéciales de la tour ne vous en dispensent. Ce faisant, vous concentrez dans le jeu les effets sonores; vous groupez les différentes tonalités avant d'obtenir le dégagement parfait de l'accord harmonique: lequel, par ses vibrations fusionnées, charmera l'ouïe des auditeurs. Pour les grands carillons il reste cependant à placer les bourdons. En général, cela n'inquiète guère l'architecte ou le fondeur de cloches, qui s'empresseront d'utiliser la place disponible réservée au dégagement des ondes sonores. Le carillonneur moderne, ayant comme objectif l'effet intense à obtenir dans les performances artistiques, ne sera point du même avis.

En effet, n'ayant plus le choix de la place, il faudrait forcément suspendre les grosses cloches autour de l'ensemble du carillon. Il en résulte: (*a*) un entassement de la chambre des cloches; (*b*) un placement arbitraire et irrégulier des connections; (*c*) une suspension de cloches coudoyant ou masquant même les ouvertures. Or, placés en privilégiés, ces bourdons domineront, par l'ampleur de leur sonorité déjà supérieure aux autres cloches. L'artiste, malgré une impeccable exécution, ne saurait produire dans son jeu la fusion complète de toutes les tonalités. J'en fais ici un grief au beau carillon de Bruges. La supériorité de celui de Malines tient de son emplacement modèle en cloches et mécanismes. On y trouve les six basses placées à un étage inférieur. Des abat-sons ferment les ouvertures, en font une chambre close et mystérieuse. La sonorité y est tempérée—se mêle en accompagnement discret à l'ensemble harmonique. Les cloches étant placées à l'intérieur de la tour, en rangées superposées et symétriques, laissent toute la place nécessaire à l'adaptation régulière du mécanisme à cylindre avec les connections du jeu des marteaux d'un côté; du mécanisme à manuel avec les communications du jeu des battants de l'autre.

Le mécanisme du cylindre se place généralement à l'étage immédiatement inférieur à la chambre des cloches. Il se compose d'un tambour dont la matière est de bronze, laiton ou fer. Il est percé d'innombrables trous, ronds ou carrés. On y place les tacquets à vis, fixés par un écrou à l'intérieur du cylindre. Ces tacquets correspondent à des claviers en acier auxquels sont attachées les connections en fil de fer galvanisé. Au moyen d'une équerre de transmission le fil est mené au marteau, en repos sur un ressort d'acier—celui-ci fixé et ajusté devant la cloche. Dans sa rotation le cylindre, armé de tacquets, bascule les leviers. Ceux-ci soulèvent les marteaux, qui frappent extérieurement la cloche à son rebord inférieur. Chaque cloche, selon son rôle d'importance, possède un, deux, trois ou quatre marteaux. Une répétition précipitée de la note, dans une même mesure, exige l'emploi de différents marteaux. Le rôle d'importance d'une cloche varie selon la mélodie et la tonalité de base. A cet effet, il y a des installations où les cloches sont munies en surplus de marteaux de réserve, appelés "de rechange." Chaque rangée de trous au cylindre, prise dans le sens horizontal, indique la totalité des marteaux actionnés. Dans le sens de la circonférence le nombre de trous correspond à celui des mesures. Ainsi le cylindre en bronze du carillon de Malines actionne nonante marteaux, compte cent et quatre vingts mesures. Il est percé de $90 \times 180 = 16{,}200$ trous carrés. Le plus grand cylindre connu est celui du carillon de Bruges. Dans l'impossibilité d'émettre une estimation exacte, je puis néanmoins affirmer que le nombre de trous dépasse les trente mille. L'espace qui sépare chaque rangée est uniforme. Sur une matrice spéciale on divise cet espace en seize ou vingt-quatre parts égales, à l'effet d'ajuster les différents tacquets. On emploie ces divisions *ad libitum* selon le mouvement lent ou accéléré que l'on veut imprimer à la mélodie. Au mécanisme automatique du carillon d'Utrecht (Hollande) j'ai constaté récemment l'emploi d'une note unique, variable dans ses divisions, dont l'ajustage se fait par suite d'une ingénieuse adaptation d'un mécanisme spécial, déplaçant le cylindre. Je félicitai l'auteur pour sa trouvaille tout en émettant des doutes sur le côté pratique de la nouvelle invention. Adapter les airs au cylindre est une opération vulgaire à la portée d'un chacun. Cela s'apprend très facilement. Dans la musique écrite on marque les notes du chiffre correspondant à la division du tacquet qu'on place. Dans le sens de la largeur du cylindre on appose au préalable une latte indiquant le nombre des marteaux de chaque cloche, composant l'ensemble actionné. L'arrangement de la musique est chose capitale. Le carillonneur

peut y prouver plus ou moins de savoir. Enfin, un volant régulateur, mis en mouvement par le contact de trois arbres de transmission munis de rouages, assure au cylindre son mouvement régulier et uniforme. Un poids moteur actionne automatiquement l'ensemble du mécanisme. Ce jeu du marteau sur la cloche peut produire un effet agréable, mais ne saurait donner aucune expression à la performance. Elle reste toujours incolore.

Tel n'est point le cas du mécanisme à manuel pour carillonneur. Tout en conservant l'ancien et rudimentaire système, nous avons réussi à perfectionner cet instrument à tel point qu'il nous est loisible, en maintenant toute la virtuosité d'en temps, d'interpréter les mélodies simples de la façon la plus expressive. Je viens de vous dire que le mécanisme à cylindre actionne les marteaux à l'extérieur de la cloche. Notez que le carillonneur manipule les battants suspendus à l'intérieur. L'instrument se place devant les cloches, au même étage, se joue du poing. Le mécanisme à manuel se compose de deux soutènements de côté, en bois de chêne ; reliés dans leurs parties supérieures par deux encadrements dans lesquels se placent les touches en bois. L'encadrement de devant sera en fer. Les parties inférieures sont de même munies de deux encadrements pour le jeu des pédales. L'étendue du registre des pédales pour grands carillons se limite ordinairement de la basse fondamentale à la quarte de la deuxième octave. Une série de barres de fer pivotantes à équerres droites, placée à l'intérieur du manuel, relie les touches aux pédales. Les connections primitives, comme on les trouve encore adaptées à la plupart des instruments campanaires des Pays-Bas, se composaient simplement d'un fil de fer, muni d'un tendeur à vis ; pour former l'angle intermédiaire on usait d'un anneau centralisant le fil de la touche, celui du battant, enfin un troisième attaché à un point quelconque pour assurer l'équilibre de l'ensemble. La connection prenait fin au battant. Ce système présentait le défaut de produire trop d'élasticité, un réglage insuffisant de la touche, laissait le battant à ballotter de façon par trop nonchalante. Pour y obvier, nous construisîmes tout un échafaudage de barres de fer pivotantes, placé devant le beffroi de suspension, se développant en étendue proportionnelle à celle des battants de cloches à actionner. Chaque barre est munie d'une équerre droite, placée à fil de plomb au-dessus de la touche du manuel ; d'une équerre recourbée qui mène le fil devant le battant en position normale. De cette façon les connections de la touche au battant passent par un seul angle droit—rigide—absolument dépourvu d'élasticité. Le tendeur à vis, suspendu précédemment au fil, est remplacé par une plaque à vis, fixée dans la touche même, et en permet un parfait réglage. Pour assurer la flexibilité des connections on coupe les fils d'œuillets à espaces déterminés. Pour tenir leur rigidité et éviter ainsi les ballottements encombrants on les enclave à distance. A la partie inférieure du battant de la cloche on applique un œuillet à vis où se concentrent les quatre connections nécessaires au parachèvement de l'installation. D'abord le fil de l'équerre au battant, dont la disposition est symétrique pour toutes les cloches régulièrement placées. Ensuite les fils emprisonnant l'œuillet de droite et de gauche ; établissant une liaison entre battants ; réglant les mouvements de balance tout en assurant la liberté nécessaire pour la parfaite manipulation. Enfin le fil mené à un ressort de rappel, placé derrière le battant. Ce ressort de rappel, qui marque le point terminus de la connection, est une pièce de détail d'une importance capitale. Il joue le rôle de force négative combattant l'effort positif créé par le coup de poing du carillonneur. Placé entre ces deux tractions opposées, ce morceau de fer, martelant le bronze sonore, s'anime alors. L'artiste parvient à le maîtriser, à le dompter, à le vivifier même. Tout l'ensemble du mécanisme des connections est bien simple et n'exige point de connaissances spéciales pour sa fabrication. Seulement la position exacte de toutes les pièces de détails doit être judicieusement comprise ; le placement bien ordonné. Cela nous permet alors d'atteindre une expression intensive dans l'interprétation, grâce à la nouvelle méthode de jeu.

Le jeu primitif consistait dans la performance d'une simple mélodie ou dans l'exécution d'une série d'arpèges et d'exercices techniques. L'art du carillonneur atteignait un rythme plus ou moins cadencé. Certes, les plus habiles montraient des qualités hautement appréciables, mais qui en somme se limitaient à une virtuosité d'acrobate. Le jeu, quelquefois agréable dans sa naïveté, restait néanmoins toujours incolore. Les différentes valeurs de notes s'interprétaient simplement du même coup de cloche suivi d'une pause d'attente adéquate. Que pouvait-on faire ? . . . Parmi les perfectionnements apportés à l'ancien système se trouve la plaque à vis adaptée à la touche, qui nous laisse la faculté d'un minutieux ajustage. Les perfectionnements de détails apportés au mécanisme des

connections nous permettent de nuancer à volonté; cela d'une manière parfaite. Nous essayâmes le jeu comparé—c'est à dire, nous rendîmes la mélodie en octave, en tierce, en sixte, ou par accompagnement de simple note de passage. Cet emploi de différentes notes pour rendre la mélodie nous permit d'exécuter les trilles. Or les trilles parfaites, traversant l'espace, se dépouillent de toute rudesse; se fusionnent complètement; arrivent à l'ouïe des auditeurs donnant l'impression et le charme du chant soutenu. Partant, le problème de la valeur effective et réelle de la note fut résolu. C'est là tout le secret du jeu moderne. En ce qui concerne les grands carillons à quatre octaves, qui possèdent les basses profondes, l'effet le plus intense s'obtient au moyen du contraste créé par l'emploi du jeu comparé des deux extrémités. Pas de médium. L'accord harmonique soutenu des cloches au son cristallin bien trillé, en accompagnement de simple bourdon, est vraiment impressionnant. Tous les carillonneurs ne réussissent point dans ce genre de performance. Un jeu nerveux et concentré, s'alliant à l'ajustage parfait de la touche, est absolument requis. Une connaissance profonde de l'instrument, dans tous ses détails, est nécessaire. L'artiste étudiera toutes ses cloches et en caressera les privilégiées. Par exemple: il vous jouera au carillon de Malines la marche funèbre de Chopin en *sol mineur*, à Bruges et Anvers en *ré*; une Sixième Sonate de Valentin Nicolaï en *si* ♭, ailleurs en *ut majeur*. Tout cela dépendra de la tonalité de base, de la qualité des cloches, des dispositions générales de l'ensemble. Il évitera l'emploi de telle tonalité. Il arrangera la musique en conséquence, pour ne point faire ressortir les défauts inhérents à tout carillon.

La composition d'un programme de concert demande beaucoup de soins. L'assistance est très variée: intellectuels, artistes, musiciens, gens du peuple—instruits ou non éduqués! Il faut en venir à contenter tout ce monde. Pour un auditoire nouveau on jouera de préférence des airs connus et populaires; des mélodies simples à conception facile. Il m'arriva en 1891 de jouer du carillon à Aberdeen en Écosse. Je présentai au public un programme de concert qui m'aurait valu en Belgique l'approbation générale. L'Écossais resta froid. Au premier moment j'en fus quelque peu désappointé. Le mystère fut vite éclairci cependant. J'insérai au programme d'un deuxième concert une série d'hymnes religieux très en vogue. Les milliers de voix d'un nombreux public accompagnèrent en chœur. Le succès complet couronna mes efforts. Le carillonneur éveille l'attention du public initié en entamant un prélude à séries de brillants arpèges, immédiatement suivi d'une performance qui nécessite une grande virtuosité. L'auditoire est conquis d'emblée. Il interprétera ensuite, en contraste, une suite de mélodies au jeu simple et charmant, quoique toujours profond et très soigné dans l'interprétation. Une musique classique, variante nécessaire, divisera nettement le programme et aura l'avantage de plaire aux musiciens et aux intellectuels. La deuxième partie se composera d'un autre genre de mélodies, entrecoupées de morceaux caractéristiques allant toujours en gradation pour arriver à une exécution finale ou le carillonneur, usant de tous ses moyens, de toutes ses facultés, atteindra un maximum de nuances, qui laissera le public abasourdi sous l'effet de l'impression la plus profonde.

Le carillonneur doit, en général, jouer de mémoire. Une lecture suivie de la musique le distrait de son clavier, l'empêche de se donner librement à la manipulation de la touche. Toute interprétation doit porter un cachet personnel. Ces prédispositions spéciales doivent être doublées d'initiative et de développement intellectuel. Il en manque malheureusement à beaucoup de carillonneurs, et par le fait plus d'un doit forcément négliger le côté artistique.

Pour obvier à cette situation on songea à fonder une école nationale de carillon. Les plans en furent dressés par mon *alter ego*, M. Édouard De Keyzer, de Malines, en collaboration avec notre ami Henry De Coster. Outre le cours de technique on y enseignerait l'esthétique; l'histoire de la cloche; l'harmonie spéciale et simplifiée à y adapter. Les plus hautes notabilités sociales, religieuses et administratives, donnèrent leur adhésion. L'État, la Province, la ville de Malines, un comité de généreux donateurs voulurent assurer la stabilité de l'institution nouvelle, quand la présente guerre vint reculer la réalisation de nos projets à une date indéterminée.

Les concerts du soir à Malines datent de 1892. Ils se donnent les lundis aux mois de juin, juillet, août et septembre, et furent institués grâce à l'initiative de feu M. l'Échevin Théodore De Coster de regrettée mémoire. Au début, la tâche fut quelque peu ingrate devant l'indifférence quasi générale. Quelques rares me comprirent; ils suivirent assidûment les performances. A cette époque, ils étaient les seuls visiteurs de la "ruelle sans fin," si réputée de nos jours. A

la clôture de chaque saison, ces quelques amis de l'art — professeurs, peintres, sculpteurs, musiciens—tenaient à me serrer la main en signe de gratitude; m'encourageaient à persévérer dans le travail difficile que j'avais entrepris. Je trouvai une aide précieuse dans la collaboration active et désintéressée d'un homme de talent, M. Édouard De Keyzer, qui se fit le manager du carillonneur. Il organisa la propagande, publiant les programmes périodiques sous forme de petits livrets qu'illustrèrent des artistes de renom, parmi lesquels j'aime à rendre hommage à mon ami, le peintre malinois Albert Geudens. L'intérêt grandissait. Le concert extraordinaire donné en l'honneur des membres du Congrès Néerlandais siégeant à Bruxelles en 1906, les concours pour carillonneurs organisés sous les auspices de l'État et de l'Administration communale, finirent par secouer la torpeur publique Les étrangers affluèrent et l'assistance toujours plus nombreuse devint cosmopolite. Les lundis de chaque semaine, arrivèrent en files interminables de pèlerins, ces fervents de l'art nouveau se rendant aux emplacements privilégiés, s'installant en plein air au risque d'encombrer la circulation publique. L'autorité intéressée dut prendre des mesures spéciales pour réglementer et suspendre même en certains rayons tout traffic durant l'heure du concert. Sur la proposition de feu M. Franz Van Kuyck, alors échevin des beaux arts, la ville d'Anvers organisa avec succès des concerts de ce genre. Gand, Bruges, Mons, Louvain, d'autres villes encore, restaurèrent leur carillon et s'en furent à l'exemple de Malines et d'Anvers. Quand au soir d'une journée estivale, fatigué du labeur quotidien, il vous est donné d'admirer les beautés de la nature—la tour géante se dressant en pénombre sur un ciel étoilé—à travers le vert feuillage le rayon glissant d'une lune argentée—ah! dans pareil cadre, le chant de la cloche incarne la plus merveilleuse féerie que l'oreille humaine puisse entendre, un régal d'art que la presse belge ne craignit point d'affirmer unique au monde. Le juriste éminent et universellement connu, Edmond Picard, proclama l'effet merveilleux d'émotion, de pénétration et de grâce. La tour, dit-il, devient un être vivant, ouvrant ses puissantes lèvres, remuant sa lourde langue de métal; dilatant ou resserrant son gosier de granit. Tout est force, sonorité ou souplesse. M. Auguste Michotte, de Bruxelles, sous l'impression du dernier concert donné au mois de juillet 1910, s'exprime ainsi:

"A mesure que se déroule le programme, l'impression devient plus haute, plus grave, plus profonde, et quand pour finir le carillonneur joue son prélude, une sorte de rêverie inspirée, lorsque les dernières modulations s'éteignent dans un pianissimo impalpable, s'évanouissant et s'exaltant dans un murmure divin, je dis qu'il n'y a personne dans l'auditoire qui n'ait éprouvé le grand frisson sacré, celui qui fait trembler la voix et qui mouille les yeux. . . ."

Cher peuple anglais, je vous le souhaite, ce carillon qui éduque le peuple et ennoblit la race!

CARILLONS AND CHIMES.

By William Wooding Starmer, F.R.A.M.

This afternoon it is my great pleasure to co-operate with my old friend, Josef Denyn, on a subject which to both of us is of the greatest importance and of the greatest interest; consequently, instead of speaking to you on a particular aspect of the subject which might be completely and separately treated, I propose to supplement some of the statements M. Denyn has made, so that fuller appreciation may be possible of the special points the time at my disposal will permit me to deal with.

Lantern-slides which I have had specially made for the purpose will, I trust, elucidate some things which are very difficult to explain in words.

First I will deal with the magnificent tower of Malines, which is 320 ft. high and the finest of its kind in the world. Although not completed according to the original design, which provided a spire (the total height of the tower and spire being greater than that of any similar structure in Europe), I think it will be readily admitted that the tower, as it stands, gains very much artistically by its incompletion. It is perfectly designed for the good disposition of the carillon, and the nature of the surrounding country greatly helps the effect of the bell music and enables the bells to be heard over an extensive area. The height of the bells in the tower, too, is an important factor—the lowest being quite 200 ft. from the ground. Then there are no obstructions to prevent the sound from travelling to the furthest possible limit in any direction. In passing, it may be stated that a carillon should never be less than 100 ft. high. Of course, there are many considerations which might modify such requirements, but I doubt whether, under any circumstances, a good result could be otherwise obtained. There must be no immediate reflection of sound about the tower, and there must be no hindrance whatever to the sound travelling in all directions equally well.

The beautiful effects obtained by M. Denyn from his wonderful instrument are made possible by the excellence of the bells, the good suspension, and the satisfactory height at which they are placed.

Next the bells may be dealt with. There are forty-five—the reputed weight of the largest being $8\frac{3}{4}$ tons, while the reputed weight of the whole of the bells is $33\frac{1}{2}$ tons. The oldest bell is dated 1480, twenty-six being cast by the famous Pierre Hemony in 1674. The compass is four octaves, less one note. Many of the bells are of great antiquarian interest, and the ornamentation in some instances is very fine.

The uses of bells in this country and the special requirements of bells when made and hung for the purpose of change-ringing, have caused variations in shape and thickness which have proved to be unfavourable to the bell, when considered as a musical instrument.

Many of our bells are poor in tone and inaccurate as to tune. Change-ringing is responsible for the alteration of shape—the shortening of the body—so that the series of harmonic tones has been completely upset, to the detriment of both tone and tune.

In times gone by, instead of improving the method of bell-hanging and the proper adjustment of the balance of the bell, our forefathers indiscriminately treated the bell itself and altered it in such a way as to impair its symmetry, in order that greater ease in ringing might be attained. Now, however, this problem presents no difficulties which cannot be overcome.

A consideration of the greatest importance is the difference in the construction scale in making bells for carillon use and for change-ringing. The following table will show where these differences occur :—

	For Carillons. Cwts.	Qrs		For Change-Ringing. Cwts.	Qrs.
1	1	2	G	6	0
2	2	0	F	6	1
3	2	2	E	6	2
4	3	2	D	7	1
5	5	0	C	8	0
6	6	0	B	9	0
7	8	2	A	11	0
8	11	3	G	13	0
9	16	0	F	17	0
10	20	2	E	20	2
11	28	0	D	28	0
12	40	0	C (Middle C)	40	0

The reason of the heavier weights in the smaller bells of the change-ringing scale is to prevent them being swamped by the larger ones, and, for the purpose, increased thickness is an absolute necessity. This upsets the harmonic tones more or less, and although the most important ones can be satisfactorily dealt with, at times no tuning can completely rectify the subordinates.

Then, of course, the difference between the methods employed in sounding the bell has to be taken into account. In the carillon the clapper strikes the bell (hung "dead" or "fixed") from a very short distance; consequently no great volume of tone is produced. In change-ringing the bell completes a circle for each blow of the clapper, which thus hits the bell with great force.

Taking these things into consideration, it is difficult to make any true comparison between the use of English bells cast on a different scale and operated upon in an entirely different manner, and Continental bells made for carillon use, automatic or otherwise.

There is not much to say with reference to bell sounds produced by a mathematical formula in which musical considerations have hitherto played only a small part, although in recent years much attention has been given by composers of peals to the elimination—as far as possible—of changes containing unmusical cadences. It is not possible, however, to get rid of the unsatisfactory musical effect of the finals of some changes.

Far be it that change-ringing should in any way be discouraged, but music played from the clavier raises the bell to a much higher plane and makes the musical expression almost as great in its possibilities as in pianoforte playing. It is difficult to realise how such effects can be obtained by means of a mechanism that is of comparatively rude construction. There is much room for improvement in the action-work connecting the clavier with the bells, but there is not the slightest difficulty in accomplishing this.

It is probable that in the near future the action-work will be pneumatic, electric, or both—ensuring such control of expression that the player can use a keyboard identical with that of the pianoforte, thus avoiding the great physical exertion which is now often necessary. With such an action the finger will do what is now done by the hand, and the playing of the pedal will be no more laborious than is the case with the modern organ.

The clavier is arranged on the same principle as the manuals of an organ. The keys are made of oak. They are round, being about $\frac{3}{4}$ in. in

diameter. There are two rows of them, the upper representing the black notes of the ordinary keyboard, projecting 3½ in., the lower, corresponding to the white ones and projecting 6½ in. The pedals are one octave or more in compass. The pedal board is a necessity, because the larger bells require much more force to bring out their tone. The clappers are consequently much heavier, and demand a considerable expenditure of energy to move them. The pedal clavier also greatly increases the resources of the instrument, and permits the music to be played in three or more parts.

The keys are struck with the closed hand, the little finger being protected with a leather covering to prevent injury when playing. As the leverage of the key has to move the weight of the clapper, which in large bells is very considerable, and as the amount of tone produced depends entirely upon the amount of force with which the key is struck, it will easily be understood that carillon playing requires a great deal of strength as well as celerity and skill.

The connection between the key and the bell clapper is exactly the same in principle as the tracker action used in organs, iron levers, squares and wires being used in the place of the wooden materials of organ building. On the clappers of the smaller bells springs are fixed to bring them back into their original position quickly after striking. In the larger bells the clappers are too heavy for this arrangement. They have a simple appliance consisting of a chain which is attached to the "flight" of the clapper and passed over a pulley. A weight is fixed to the other end of the chain sufficiently heavy to bring the clapper within a very short distance of the sound-bow of the bell, so that the key has only to upset the balance between the weight and the clapper.

The mechanism connected with each key is fitted with an adjustable screw-plate, or other device, by which the tension can be regulated to a very great nicety and the touch adapted to the requirements of the player.

The bulk of the playing is done on the smaller bells, with only occasional use of the larger ones. The reasons why this should be so are:—

(1) The small bells are more easily manipulated;

(2) The effect of chords is much more satisfactory than on the large bells, owing to the fact that in the latter the harmonic tones are very prominent and frequently interfere with each other when sounded together in a disagreeable manner.

This is not the case with the smaller bells when used in combination, as their harmonic tones are too high in the scale of sounds to inconvenience the ear.

Concerning the chime apparatus there is much to be said. With us melody only is played, and rightly, too, for, as a rule, our bells are much heavier than those on the Continent, which are used for two, three, or four-part harmony. Heavy bells, especially when the notes are near together, would be unbearable in combination, because their harmonic tones would greatly interfere with each other. This interference would be greatly accentuated in any extended compass, because until recent years all sets of bells in this country—whether diatonic or chromatic—have been on the ringing scale, which means that they are thicker and heavier than they should be for carillon use. Perhaps this has been unavoidable, as in several instances a specified number of bells in the scale have been hung for change-ringing. It is well to state that it is most undesirable to make bells on the ringing scale for carillon use, and it is equally undesirable to use bells made on the carillon scale for ringing purposes. The demands in both instances differ widely, and the bells cannot be made to serve two purposes satisfactorily or equally well. Until recently this has not been properly understood in England. The late Lord Grimthorpe is responsible for much of the trouble relating to thick bells. He insisted on having all bells over which he had any jurisdiction made on an abnormally thick scale. Experience has shown that on this point he was wrong, although his crusade may have prevented many bells from being made too thin.

Our ancient chime machinery is very simple, and consists of a weight-driven barrel, sometimes as large as three feet in diameter, generally made of wood, into which pins are fixed on exactly the same principle as in the barrel of a musical box.

The pins in the chime barrel pulled down levers which lifted the hammers with which they were connected by wires, and released them so that in their descent they fell upon and struck the bell from the outside.

In passing, I might mention that in mechanical chimes the hammers always strike the bell from the outside.

Of course, in such a machine the barrel had to do all the work. It was satisfactory so long as the requirement was merely the playing of a regular succession of notes of equal value at a moderate speed—a simple hymn tune, or the

like. But as there are very few melodies of real interest which come within these limits, particularly as regards secular tunes, more elaborate airs consisting of unequal notes, mixed long and short note values, groups of short notes in quick succession, etc., were set on the chime barrel. Such demands had the effect of obliterating everything in the shape of correct time in the rendering of the music, because the chime barrel with the same motive power had to play, perhaps, four notes in the same time as one which preceded the group of four and two which followed, *e.g.* "Rule, Britannia!"

As you can well understand, these unequal demands made the speed of the barrel very irregular, with the result that one bar was played at a quicker or slower time than another. This made the musical effects of many chimes very unsatisfactory, and, in not a few instances, quite grotesque. The fault was in trying to make the mechanism do what it was incapable of, and for a time, no doubt, this tended to mar the popularity chimes had gained.

About fifty years ago improvements in chime mechanism were made by Messrs. Lund and Blockley. The general principle was good, but certain parts of the machine were too weak to bear the strain of the very heavy driving weight used.

Other improvements were made by Messrs. Gillett, of Croydon, who erected their first carillon machine at Boston parish church in 1868. The particular advantage of their machine is that it divides up the mechanical operations. A separate movement is fitted to raise the hammer-levers into action immediately after they have fallen and struck the bells. When raised into position they are prevented from falling by a spring trigger which can be released by the slightest touch. The only work the chime barrel has to do is to release the triggers, so that the demand on the barrel is reduced to a minimum.

The most recent invention in our carillon machinery has been made by Messrs. Smith and Sons, of Derby. It differs from Messrs. Gillett's machine principally in the subdivision of the driving power.

Each hammer, or set of hammers, has its own special mechanism driven by a separate weight instead of the motive power required being derived from one source, as is the case with other machines. Consequently the weights are so adjusted that the driving power is at all times adequate for the proper working of the hammers, individually and collectively. I mean that, however great the demand is, it never makes the smallest difference in the efficient working of all the parts, thus securing perfect time in the playing of the tunes.

This is a decided advance, and with such a mechanism almost anything can be played, although it is undesirable to set very quick tunes on the chime barrel.

At Malines, in some instances, there are as many as four hammers to each bell, so as to ensure the quick repetition of the note when required. The connections there between the chime-machine and the hammers are made by means of wires, squares, etc., just as in our own chimes. These vary from fifteen to forty feet in length. Although the connections are in appearance somewhat clumsy, they require a very nice adjustment.

The chime-barrel is made of gun-metal, with two rim cogs and a centre guiding cog. It was cast in 1733, completed in 1734, and is 5 ft. 3 in. in diameter. The driving weight is 1 ton 6½ cwt., being about 4 cwt. in excess of that which is absolutely necessary for the purpose. The chain to which the weight is attached is over 90 ft. long, and is wound round an oak drum fixed on the axle of the chime barrel, so that the weight-force exerted is direct—*i.e.*, there is no gearing.

The chimes are set twice a year—at Easter and in October—and as the barrel is a permanent part of the mechanism the chimes can only be altered by a rearrangement of the studs. This takes about four days to do. There are no interchangeable barrels such as we have in England —a disadvantage; but against this must be set the greater accuracy of the rendering of the music obtained by using a large barrel, and by providing such generous driving power.

The Malines chimes play no less than eight times during the hour: a short flourish at each half quarter, a short piece at the quarter before and after each hour, a longer piece at the half hour, and at the hour a piece of still greater length. The hour is struck as in England, but the hour to come is announced after the half hour on a smaller bell than that used for the hour strike.

In our own country many of the disgusting exhibitions we are forced to listen to, and which in many instances set people against chimes, are the result of gross carelessness and inattention to the proper upkeep of the chime mechanism. In many instances, when chimes are put in a church and set going, there seems to be a general idea that they will work for the next

century without any attention whatever. If mechanical chimes are to be successful they require very frequent attention and regulation. The chimes at Malines could never be so satisfactory if it were not for the fact that they are under the constant care of an expert specially employed to look after them, and who almost lives in the tower.

It is not so long ago that our bells and belfries were allowed to get into a very disgraceful state. Now, happily, this is utterly changed; but I regret to say that chimes, generally speaking, are grossly neglected.

The adjustment of the hammer connections and the regulation of the different parts require just as much care and attention as the action of a pianoforte, to ensure the most satisfactory results and to prevent the extravagant wear and tear of the mechanism caused by neglect.

In conclusion, I cannot do better than repeat what I have already said on many occasions when lecturing on this subject. The carillon with clavier is the finest musical instrument in existence for educating the people in and cultivating their love for folk-songs and in teaching them the great melodies of their fatherland; for the music best suited to the carillon—excepting music specially written for the instrument—includes the folk music which has successfully stood the test of time.

In reply to questions asked by members of the audience, MR. STARMER said the bells were struck by iron clappers. The first carillon in England was put up at Cattistock, in Dorsetshire, in the church of Mr. Stickland, who was present that evening, and he believed it consisted of thirty-six bells, three octaves in compass. There was also a carillon of thirty-three bells at Bournville, a carillon at Liverpool, in Messrs. Taylors' foundry, and a carillon of thirty-seven bells at Aberdeen. He was sorry to say the last was out of gear, and it was now impossible to play it. The Scotsmen, he believed, thought it would be rather loud, and when it was opened they went to the neighbouring hills about Aberdeen, but could not hear it; and he did not think they had taken very much interest in it since. There was one question which he was very pleased indeed to be able to answer. As far as he could gather from the most authentic information it was possible to obtain, a communication which was probably the latest that had been received from Malines, the tower was practically undamaged and the bells were intact. Anyone desiring further particulars on any points mentioned in the paper would find the whole subject of carillons dealt with and illustrated in the *Musical Times* of April and June this year; the articles mentioned all the carillons in England, and gave a scale of the weights of bells, etc. With regard to the complaints frequently heard of inharmonious bells and disjointed playing, if it were chime-playing it would be the mechanism that was at fault, but if the bells were played from a keyboard or chiming-machine the defect would be due to the player. He hoped that when they reached home the audience would attempt to play "God Save the King" on the eight notes of the scale, as it would teach them what some people had to put up with. He had heard it played, and as the players had not the leading note in the right part of the scale they took it up several notes. It reminded one of Mendelssohn's scoring in one of the songs in the "Midsummer Night's Dream." With regard to tuning, if the bells were tuned on a good system—and there was only one system, the right one—there could be no disagreeable effect from hearing bells in succession. Most of the peals of bells in England, especially those made by itinerant bell-founders, were exactly what one would expect them to be. If a bell had one series of harmonic terms and the next one had something quite different, it was impossible to get any musical sequence at all. If the bells were tuned as they should be, and as all good bells of the master bell-founders, such as Hemony, were tuned, with so many perfect octaves, no one would have any difficulty whatever in listening to bells, or even in being able to judge whether they were or were not in tune. With regard to tubular bells, he did not think any *carillonneur* would deal with them; at any rate he had never dared ask a *carillonneur* that question.

On the motion of the CHAIRMAN a hearty vote of thanks was accorded to the authors of the papers.

TUNGSTEN IN BURMA.

It is only within the last few years that tungsten and its various salts and alloys have been brought into general use. Its employment in the manufacture of filaments for incandescent lamps has, of course, made this particular use of it very familiar; but its chief value lies in the fact that when it is added to steel the latter acquires the property of "self-hardening" and requires no tempering, and this hardness it retains at red-heat. This renders it extremely valuable for high-speed cutting tools; as a matter of fact, over four-fifths of the total outturn of tungsten is now absorbed in the manufacture of ferro-tungsten, containing between 50 and 85 per cent. of tungsten and amounts of carbon varying from ½ to 5 per cent.

The salts of tungsten are also used in certain industrial processes, such as dyeing, fire-proofing, the differential analysis of tanning materials, and the manufacture of bronze colours.

Until comparatively recently the chief source of supply was the United States, but some five years ago the first serious attempt was made to develop the wolfram deposits of the Indian Empire, and Lower Burma now heads the list as the world's

greatest producer. The total production of the world is about 8,000 tons per annum of concentrates, carrying from 60 to 70 per cent. of tungstic trioxide. Of this Burma produces one quarter.

The first record of the occurrence of wolfram in Burma (according to the Quinquennial Review of the Mineral Production of India, from which these particulars are drawn) was in 1841, but prospecting was not taken up by the general public till the present century. During the years 1909-13 Lower Burma produced over 5,000 tons of concentrates with a value of nearly £400,000, and the present rate of production is about 2,000 tons of concentrates.

The ore, which always consists of wolframite, occurs primarily in veins composed chiefly of quartz, but carrying also columbite, tourmaline, molybdenite, and, very occasionally, cassiterite. These veins traverse granite and a series of metamorphosed sediments composed of slate, schist, and quartzite, and known as the Mergui series. Occasionally both tin and wolfram are found in the same lode, but this association appears to be exceptional.

The wolfram tin-bearing belt of granite and metamorphic rocks runs on northwards from Mergui and Tavoy into the Southern Shan States, and is being exploited in Bawlake State; it is also said to occur further north in the neighbourhood of Kalaw.

In India wolfram has been found in various localities, but only in comparatively small quantities.

Although the development of the industry in Burma has been extremely rapid and the profits very great, the methods have for the most part been of the most primitive description. In addition to the quartz-wolframite loads, float deposits provide a certain amount of ore, but the greater part is obtained from the lodes, which are usually worked by quarries and open-cut workings sometimes of a highly dangerous nature. The labourers are to a large extent Chinese and Telegus, with a sparse scattering of Burmese, who do not as a race take kindly to hard work of the kind involved in mining. The ore, when won, is as a rule crushed by hand and panned or sluiced. Concentrating machinery is almost unknown, but it will no doubt soon be introduced more generally, for the methods at present in vogue are wasteful and must result in permanent loss, since much of the ore now left in dumps and tailings will for economic reasons be ultimately irrecoverable.

It is now announced that the Government of India are taking energetic steps to stimulate the output of wolfram. According to the *Pioneer Mail*, the arrangements for this purpose are much on the lines of munitions legislation in this country, and the ordinance will be of a far-reaching character.

INSANITY IN MADRAS.

Some interesting figures are given by Surgeon-General W. B. Bannerman, C.S.I., in his report on the lunatic asylums in the Madras Presidency for the triennium ending 1914.

A striking fact brought out in the census report is that in 1901, 79 per cent. of all the lunatics in England were under treatment in various institutions, whereas in Madras in 1911 only 9 per cent. of those actually returned as insane were so treated, and the proportion to the total of the mentally disordered (of whom those returned as insane probably only represent a fraction) would be, of course, much less. This difference is partly due to the fact that the people of Madras have not yet recognised the value of institutional treatment in mental disease, and partly to the reluctance the people feel in removing their afflicted relatives from the family circle, especially if these relatives are females.

Unfortunately, no statistics of the incidence of insanity among the Europeans resident in Madras Presidency are available. It might be expected on *à priori* grounds that the rate would be low; as the Europeans in India are picked men and women, and if they break down mentally they return to their own country. In the chief remaining classes the incidence was found to be as follows: Eurasians (which term includes all people of mixed European and Indian blood), 415 per 100,000; Mohammedans, 34; Indian Christians, 26; and Hindus generally, 19. The high insanity rate amongst the Eurasian community is difficult to explain. To some extent it is due to a greater readiness to return their insanes as such; and doubtless the unequal battle which the community has to fight in competition with the Indian leads to numerous mental casualties. Behind these factors there is probably the fundamental fact that Europeans cannot colonise or perpetuate their race in the tropics, that degeneration rapidly sets in, and further that races of mixed European and Asiatic blood are not, as a rule, a biological success. The lunacy incidence rate, although high, is by no means exceptional when looked upon from the European standpoint, and compares favourably with that of Ireland, where, in 1907, 542 persons in every 100,000 were insane. The number of "unrestrained lunatics" in every 100,000 of the population was in Madras City, 15; in the North Division, 19; in the Deccan or North-West Division, 18; in the Central Division, 14; in the South Division, 18; and in the West Division, 27. In regard to age: those under twenty years formed 21·27 per cent.; from twenty to forty years, 42·74; from forty to sixty years, 29·12; and over sixty years, 6·87.

LAND SETTLEMENT FOR EX-SERVICE MEN.*

1. *The Importance of the Problem.*—From such evidence as is at present forthcoming, and arguing from what took place after the Boer War, there seems little doubt that a large number of the men

* Abstract of a paper read by Christopher Turner before the Economic Science and Statistics Section of the British Association at Manchester.

now serving in the forces will elect a career on the land at the close of the war. If this is so, it is clear that the machinery for providing them with land should be created without delay, and be ready before we have the ex-Service men upon our hands, probably in their thousands. Nationally and imperially it is a question of great importance. Cultivators of the soil are more needed than any other type of citizen, both at home and overseas.

It is probable that when the war is over a time of slackness will come in urban industry, which will make it all the more important that the land should employ as many men as possible. The men settled upon the land must be settled effectively and under conditions which will, as far as possible, guarantee success. They must not merely be provided with land and then left to shift for themselves. Our dominions are paying more and more attention to land settlement. Sound and attractive conditions have been created. If we are to retain our fair and necessary share of ex-Service men within the United Kingdom, we must create conditions of settlement at least as sound and as attractive.

While not grudging to our dominions a share in the number of settlers, we must ever keep in mind that the first essential is to build up the agricultural population in the mother country, and from the overflow of that population to send out to our dominions the type of men which they stand most in need of.

2. *The Sufficiency of Land in the United Kingdom.*—There is sufficient land available for a very large scheme of settlement at home. No attempt should be made to create settlements in every county. They should be created where the land and conditions are most favourable. Large areas of land change hands every year, and land for the ex-Service men could, as a rule, be obtained in the open market. Several hundred thousand acres of agricultural land change hands every year. With the exception of heavy clay, nearly any type of soil is suitable for small farming.

If areas of not less than 1,000 acres are bought, nearness to a station is not essential, as the colony would be large enough to afford social amenities of its own, and to organise a system of motor transport. The settler, under proper guidance, should make a good living off twenty-five to thirty acres in the case of a small farm, and off five to ten acres in a fruit-growing and market-gardening district. As in the case of the Small Holdings Act, compulsory clauses will be necessary, but probably would rarely be resorted to.

A certain amount of land would have to be taken from sitting tenants. There are many men holding two or three separate farms with an aggregate area of from 2,000 to 5,000 acres, in districts well suited to small farming; for the general good it would be quite legitimate to reduce the area held by these large farmers.

3. *Suitability of ex-Service Men as Cultivators of the Soil.*—It is the opinion of many in this country that to be a successful small-holder a man must have been brought up on the land; but that this conclusion is altogether unsound has been proved by the settlements in the United States and in our colonies of urban artisans, which have succeeded admirably. But the conditions of settlement for men without previous agricultural training must be entirely different from the conditions under which trained agriculturists can fairly succeed.

There is no example up to the present time in the United Kingdom of a carefully thought-out land settlement scheme where the fundamental principles necessary to success have been observed. Settlements of ex-Service men can be successful only where the right conditions have been created.

4. *Conditions of Settlement.*—Certain guiding principles must be observed which have met with unvarying success wherever scientific land settlement has been undertaken. They are: (1) Ownership rather than tenancy; (2) easy access to capital; (3) settlement in colonies rather than in isolated units; (4) effective expert guidance; (5) co-operation, or, at all events, organised buying and selling; (6) the initial years must be made as easy as possible financially.

5. *Machinery.*—If ex-Service men are to be settled satisfactorily, it is quite clear that they will have to be treated differently from the ordinary applicants for small holdings.

As has been pointed out, in most cases they will be without agricultural knowledge, and, therefore, will require special conditions. The conditions advocated should, from the point of view of securing efficiency, be created for all settlers, but in the case of the ex-Service men they must be created, or the movement will end in failure.

The county councils, in settling small-holders, have paid little or no attention to the principles enumerated above, and which should be observed in all land settlement. The Small Holdings Act has not proved itself to be a Land Settlement Act. Under it many tradesmen have been given a bit of accommodation land, or men already holding some land have obtained additional land, but the number of new cultivators placed on newly-equipped holdings is very small—only 754 up to the end of January 1914.

County councils ought not to be asked to undertake this work. Few members of their small-holdings committees have in any way studied or understood the problem of land settlement. This work of settlement should be carried out by a Land Settlement Commission, composed of highly-qualified men, and in many ways analogous to the existing Development Commission.

This Commission would naturally concern itself with settlement in the United Kingdom, possibly only England and Wales. But the question of settlement in the United Kingdom should not be kept in a watertight compartment. There should be another commission or committee possessing advisory and consultative powers only, which

would review the question of land settlement throughout the Empire, and endeavour to bring about an understanding between the Home Government and the Dominion Governments and the dominions *inter se* to co-relate the work of the different emigration agencies, and to endeavour to check the loss to the Empire of men settling in foreign countries.

The time has come when the whole problem of emigration and settlement should be approached scientifically, and an attempt be made to bring order out of the present chaos.

ARTS AND CRAFTS.

The Arts and Crafts Exhibition Society.—The Arts and Crafts Exhibition Society can hardly be said to have proved by its recent exhibition that it is abreast of the times, or peculiarly capable of adapting itself to the new conditions involved in the war. The show was, owing to the national situation, on a much smaller scale than the usual triennial exhibitions of the Society, it consisted solely of the work of members, and was open for a few days only at the Art Workers' Guild Hall in Queen's Square, so that it is impossible to estimate from it the many activities of the members. On the other hand, it is only reasonable to expect at present that a society shall show signs of vigorous life and of adaptability to its surroundings. We have all heard so much of late of the desire of the artist to take his share in the work of the country, and to assist the manufacturer to produce wares artistically superior to those of other nations, that an exhibition, however small, of the work of artists belonging to that society, which after all has done so much for the promotion of exhibitions of arts and crafts not only in England but abroad, if not of the movement itself, led one to hope that it would give some hint of how the members of so important —one might almost by this time, since the society is some twenty-five years old, say venerable—a body proposed to assist in the work which was toward. Any hopes of that kind were, however, grievously disappointed. The objects collected at Queen's Square were some of them beautiful and many of them extremely well executed, and they nearly all gave evidence of being the output of artists keenly interested in their craft and all things pertaining to it; but work with any connection with trade or manufacture was to seek. It is true that Mr. C. H. St. John Hornby showed some printing, and Mr. Vigers some hand illumination of printed books; but with the exception of these and some very workmanlike designs for printed (actually roller-printed) cotton fabrics by Mr. Alfred Carpenter, the visitor might have imagined that he was living in an age when mechanical appliances on a large scale were quite unknown. This fact is to be deeply regretted. It almost makes one wonder whether a society which in its day has done much really good work has not outlived the limits of its usefulness. No one, of course, denies the beauty of handwork, or its charm; but people in general do want to be assured that the outlook of the master hand-worker, at least, is not bounded by his craft, and that he is able and willing to come into touch with what are after all the larger interests of the country.

Within the limits indicated, the objects on view were in the main really good and satisfying specimens of their class. The stained-glass cartoons included interesting work by Mr. Christopher Whall, Mr. R. Anning Bell, and Professor Selwyn Image. The full-size plaster model of the lectern to be executed in bronze and placed in the Chapel Royal, Savoy, in memory of Mr. and Mrs. Laurence Irving, was no less worthy of notice on account of its design than of those whom it commemorates. Mr. E. W. Gimson's chair of state, heavily inlaid with ivory, was an interesting and, in some respects, successful experiment, though perhaps a trifle barbaric. The simple mahogany chair shown by the same craftsman left nothing to be desired. Mr. Wilson's jewellery was as individual as ever, and gave ample proof of the artistic sense of its maker. The work of Mr. E. Woore, too, was both fresh and interesting. Miss Frances and Miss Violet Ramsey's exhibit, though less unlike what other craftworkers are doing, quite held its own, and Mrs. Louise Powell and Miss Jessie Bayes showed excellent illumination, and Mr. Graily Hewitt's beautiful writing of "The Flour and the Leef" gave one a feeling of absolute satisfaction, unalloyed by any desire to change the page in any respect. Mr. Harold Stabler's *cloisonné* enamel, examples of which attracted so much attention at Ghent only eighteen months ago, was well represented. Mr. Emery Walker sent a very satisfactory seal design. It was, perhaps, the very excellence of many of the exhibits which made one regret the comparatively small public to which they could appeal, and the limited range of their influence.

Messrs. Ramsden and Carr's Metalwork.—In the absence of Mr. Alwyn Carr on active service in France, Mr. Omar Ramsden held the usual Christmastide exhibition at St. Dunstan's Studio, Seymour Place, Fulham. This year, as last, there was not quite so much large work as has sometimes been the case; but there was enough to give point to the show, to indicate what the artists are capable of doing, and to prove that in spite of the war their work is by no means at a standstill. The work on view included some interesting designs for memorials, including one to Lord Roberts, to be erected in his parish church of Ascot, and another to a midshipman lost in H.M.S. "Aboukir." The little cross in amber and wrought gold made in memory of the Commander of H.M.S. "Monmouth," sunk in action on All Saints Day, 1914, off the coast of Chile, from his amber cigarette-holder and the gold of the case which contained it, is a singularly satisfactory solution of what must have been a difficult problem. At the base of the amber cross is a

naval crown in gold in delicate *repoussé* work, and below that a band of work symbolising the river of eternal life. The Stanley memorial chalice for Whiteland's College, Chelsea, was both an unusual and a suggestive piece of work. Four figures, in canopied niches—representing St. Catherine of Alexandria, patroness of education and colleges; St. Martha, patroness of housewives; St. Cecilia, patroness of music; and last but not least, St. Ursula, patroness of women devoted to education, clothed in an ample mantle in which she enfolds three young girls—uphold the knop beneath the bowl of the cup, and form a peculiarly fitting decoration to a vessel belonging to a training college for women teachers. In a different vein the covered standing salt, designed and executed for the Worshipful Company of Merchant Taylors, its base supported on eight symbolic towers carrying emblematic figures of the civic virtues, amongst which is introduced a figure of St. George to mark that the piece was made in the time of a great war, was an important and interesting piece of work. The heraldic achievement of the O'Reilly family of Galgary is a beautiful and effective combination of *repoussé* silver and *champlevé* enamel, in which the heraldic mantling is very well treated. The binding of the illuminated address presented to the Bishop of Kingston on his retirement by prominent members of his diocese, was rather a triumph in its way. The dark blue leather of the cover was enriched with heavy mountings in *repoussé* silver, and yet the resultant effect was a harmonious and pleasing whole. Amongst smaller works may be noted the regimental badge brooches in hand-wrought silver and gold. The examples shown were the badges of the Army Service Corps and of the 28th County of London (Artists') Rifles, and they certainly showed, as they were doubtless intended to do, that there is no reason why jewellery of this kind should not be a work of art and retain at the same time its strict military symbolism. The exhibition included, besides the large pieces, a number of small silver objects of real artistic value and some good jewellery.

Women's Craftwork.—The *Englishwoman* Exhibition of Arts and Handicrafts is always amongst the best of the winter exhibitions devoted to women's work. In former years the work has been shown at Maddox Street, and exhibits looked rather lost in the lofty Central Hall at Westminster, though certainly at the present moment Westminster is a better centre for an exhibition than any other quarter of the town. It was doubtless owing to the war that a larger proportion of the exhibits than usual seemed to be those connected with philanthropic institutions, but the show was still far less bazaar-like than most exhibitions of its type. It included the wares of well-known workers in various departments of arts and crafts, and gave a very fair idea of what women are doing in the realm of the artistic crafts. Weaving was peculiarly well represented. The colour of Miss E. M. Mairet's handwoven dress materials, scarves, overalls, etc., was peculiarly attractive, and the work of the Shottery Weaving School, which provides work for crippled girls, was also very satisfactory. The "artree" panels of Mr. A. J. Rowley—pictures carried out in veneers of woods of various colours and qualities—were many of them very good and suggested all kinds of possibilities, though one rather wondered why they appeared at an Englishwomen's show. Miss Phoebe Rennell's writing and illuminating were very pleasing, and some of her work was well adapted to reproduction. For the rest, the exhibition contained a good deal of needlework, some of it really good, and a fair amount of lace, as well as examples of what women are doing in the way of stained glass, pottery, jewellery making, leatherwork, basket-making, printing, toy-making, woodcarving, bookbinding, photography, and various other crafts too numerous to mention.

OBITUARY.

George Wheeler.—Information has been received of the death of Mr. George Wheeler, which took place on November 28th. He was born at Newport, Isle of Wight, in 1833, and he came to London about 1853 to assist his uncle, who was secretary to a number of benevolent societies. Subsequently he went into business on his own account as a manufacturer of various essences and colouring materials. He was interested in many scientific pursuits, and devoted a large proportion of the considerable fortune which he had made to various public and private charities. He was a Fellow of the Zoological Society, and a member of the Quekett Microscopical Club, the British Sea Angling Society, and the Corinthian Sailing Club. He also gave considerable attention to nature study and model-yacht racing, and up to within a few years of his death, at the age of nearly eighty-three, he regularly went out sea-fishing.

Mr. Wheeler was elected a member of the Royal Society of Arts in 1903.

GENERAL NOTES.

Books for H.M. Forces.—The Board of Education have issued an appeal on behalf of the Camps Library, an organisation for receiving books and magazines from all parts of the country for the use of His Majesty's Forces, and distributing them continuously and systematically. The Post Office organisation has been placed at its disposal as a collecting agency by the Postmaster-General. It sends out parcels of books to all units of the army, and the camps at home and abroad. The demand for books is practically unlimited. It is, in the first instance and most largely, for good fiction, and, in particular, for the small sixpenny, sevenpenny, and shilling editions of novels (bound in cloth, not in paper covers) which have recently

become so common. This demand still continues unabated, but there is also a demand, not as yet adequately met, for books of a more solid character —*e.g.*, historical and scientific works, poetry, essays, works on economics, biographies, pocket dictionaries and grammars (particularly French and German), volumes of well-known series such as the Home University Library, pocket Shakespeares, text-books in mathematics and science. Bulky books are unsuitable. All should so far as possible be of a small size, light and easily carried and complete in one volume. Books may be handed in over the counter of any Post Office in the United Kingdom, unwrapped and unaddressed, and will be delivered free of charge by the Post Office to the depôts of the Camps Library. Other communications, or contributions towards the expense of carrying on the work, should be sent to the Secretary, Hon. Mrs. Anstruther, at the Camps Library Depôt, 45, Horseferry Road, Westminster, S.W.

New Zealand Rabbits.—In the course of a paper recently read before the Cold Storage and Ice Association, Mr. Charles Tabor gave some statistics as to the numbers of frozen rabbits imported into the United Kingdom from New Zealand. The high-water mark was reached in 1910, when the number of crates was 113,685. The figures for the succeeding years have been:—in 1911, 109,565 crates; 1912, 92,488 crates; 1913, 69,373 crates; and 1914, 69,084 crates. The falling-off during the last eighteen months is due in part, no doubt, to the war; for a large number of boats with refrigerating holds have been commandeered by the Government; freight rates have advanced greatly, and consequently selling prices have risen almost to breaking-point. Mr. Tabor is of opinion that, taken as a whole, the New Zealand rabbits are better suited for the trade of certain parts of England than other rabbits; the carcasses are larger and the fur more valuable for purposes of felting—rabbits coming from the South Island are generally very fat, partly owing to the cooler climate, and the less frequency of that curse of Australasia, drought. The number of rabbits shipped from New Zealand ports is very much smaller than that sent from Australian, but then the great difference in the areas has to be considered, and also the fact that rabbits were imported into Australia before they reached New Zealand.

Bitumen Deposit in Honduras.—According to a report by the United States Special Agent in Honduras, there has been discovered on the west coast of that Republic, in the vicinity of Juticalpa, a deposit of remarkably pure bitumen or asphalt. Prospects uncovered for over 150 yards show the bed to be of great purity, and there are outcroppings for several miles. The discovery was made by an American citizen, resident in Honduras, who has the control of the property. The deposit is some considerable distance from the Pacific port of Amapala, which will have to be the port of shipment, but is on the line of route of a new model road which the Government of Honduras is preparing to construct, so that motor transportation will soon be available. Moreover, the bed is not greatly distant from the logical line of the contemplated railway from Ampala to the interior of Honduras.

Trade of Durazzo.—The trade of Durazzo, the principal port of Albania, appears to have increased considerably during the last few years, notwithstanding the unsettled condition of the Balkans. The total value of the trade of this place during 1914 amounted to ten millions of Italian lire (£400,000), of which one-fifth represented the exports and four-fifths the imports. Austria-Hungary, in spite of the war conditions which prevailed during the last five months of last year, figured to the amount of four millions of lire (£160,000); Italy, which is now taking advantage of her favourable position on the opposite coast of the Adriatic, followed with a trade of two millions of lire (£80,000), as compared with only 700,000 lire (£28,000) in 1907; Great Britain, one million lire (£40,000); Greece, about half a million lire (£20,000); and the remainder by Serbia and other countries.

Encouraging Egret Breeding in Madagascar.—With reference to the note on the rearing of egrets and herons in Madagascar, which appeared in the *Journal* of June 18th last (p. 716), it is interesting to learn that with a view to encouraging the breeding of egrets as a private industry in Madagascar, the Governor-General of the Colony has extended for three years from May 3rd last the interdiction of the shooting of egrets and false egrets, called "vorompotsys." The raising of egrets and "vorompotsys," and the sale of the plumes gathered from domesticated birds, are authorised under certain conditions. According to a report by the United States Consul at Tamatave, breeding should commence with young birds only, whose capture is authorised at the age of 10 to 45 days. The capture of full-grown birds is forbidden. The authorised capture of young birds, etc., does not extend to Green Island and the islets of the Vohemar Bay, which are reserved as producing centres of the Vohemar administrative egret farm.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

January 19.—Lawrence Chubb, "The Common Lands of London: the Story of their Preservation." Lord Farrer will preside.

January 26.—J. Arthur Hutton, Chairman of the British Cotton Growing Association,

"The Effect of the War on Cotton Growing in the British Empire."

FEBRUARY 2.—S. CHARLES PHILLIPS, M.S.C.I., "Paper Supplies as affected by the War."

FEBRUARY 9.—PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

FEBRUARY 16.—THE HON. LADY PARSONS, "Women's Work during and after the War."

FEBRUARY 23.—MISS H. B. HANSON, M.D., B.S., D.P.H., "Experiences in Serbia."

INDIAN SECTION.

JANUARY 13.—COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., late Survey of India, "The Romance of the Indian Ordnance Survey."

FEBRUARY 17.—C. A. KINCAID, C.V.O., Indian Civil Service (author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.), "The Saints of Pandharpur." LIEUT.-COLONEL SIR DAVID W. K. BARR, K.C.S.I., will preside.

MARCH 16.—PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

Dates to be hereafter announced:—

R. W. SETON-WATSON, D.Litt., "The Balkan Problem."

CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

REV. P. H. DITCHFIELD, "The England of Shakespeare."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

VICTOR HORTA, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

CHARLES DELCHEVALERIE, "Belgian Literature."

LESLIE URQUHART, "The Economic Development of Russia."

PROFESSOR T. G. MASARYK, "The Slavonic Peoples."

G. P. BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

SIR DANIEL MORRIS, K.C.M G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmyn, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

INDIAN SECTION.

Thursday afternoons at 4.30 p.m.:—

April 6, May 18.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

February 1, March 7, May 2.

CANTOR LECTURES.

Monday afternoons at 4.30 p.m.:—

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m.:—

REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "Flemish Architecture." Three Lectures.

February 7, 14, 21.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

JUVENILE LECTURES.

These Lectures will be given on Wednesday afternoons, January 5 and 12, at 3 p.m. The first lecture will be given by Professor John Millar Thomson, LL.D., F.R.S., on "Crystallisation," and the second by Mr. James Swinburne, F.R.S., on "Science of some Toys."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 20...Medicine, Royal Society of, 1, Wimpole-street, W., 5 p.m. Lieut.-Colonel Sir Ronald Ross, "The Treatment of Dysentery."

TUESDAY, DECEMBER 21...Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m.

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. A. Holiday, "The Uralsk Province and its Oilfields."

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Major J. Quayle Dickson, "The Empire's Outpost in the South Atlantic."

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FRIDAY, DECEMBER 24, 1915.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

JUVENILE LECTURES.

Two of the Members of the Council—Professor John Millar Thomson, LL.D., F.R.S., and Mr. James Swinburne, F.R.S. — have kindly undertaken to deliver the Juvenile Lectures this year. Professor Thomson will give the first lecture on Wednesday afternoon, January 5th, at 3 p.m., his subject being "Crystallisation." Mr. James Swinburne will give the second on Wednesday, January 12th, at 3 p.m.; his subject will be "Science of some Toys." Both lectures will be very fully illustrated with experiments.

Special tickets, each admitting two children and one adult, are required for these lectures. They can be obtained by Fellows on application to the Secretary.

Most of the tickets have now been issued, but a few still remain, which will be issued to Fellows who apply for them at once.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

COVERS FOR JOURNALS.

For the convenience of Fellows wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s*. 6*d*. each, on application to the Secretary.

CANTOR LECTURES ON "HOUSE BUILDING."

The Cantor Lectures on "House Building: Past and Present," by M. H. Baillie Scott, have been reprinted from the *Journal*, and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, December 16th, 1915; Sir John Prescott Hewett, G.C.S.I., C.I.E., in the chair.

The Chairman, in introducing the author of the paper, said it was a great honour to him to be present and preside on the occasion when Mr. McLeod spoke upon such an important question as the jute industry in India. He had known Mr. McLeod for almost more years than either of them would care to remember, and throughout his association with him he had always noticed that whatever Mr. McLeod did he did with all his might. Mr. McLeod had been a great success in the realm of sport and in the world of commerce. The audience might feel sure that the paper would be most instructive.

The paper read was—

THE INDIAN JUTE INDUSTRY.

By C. C. McLeod,

President of the London Jute Association.

The usual custom, when reading a paper on any particular subject, is for the lecturer to give its early history; and I am going to follow this line, but only very briefly. Before proceeding, I must give the credit for some of the information I am about to give you to Mr. R. S. Finlow, B.Sc., fibre expert to the Government of Bengal, who read a most interesting paper on "Jute and its Substitutes" at the Imperial Institute in June 1912; and more particularly in the matter of statistics which were prepared with care and accuracy. I have also gathered a lot of useful information from that excellent little book "Jute in Bengal," by K. C. Chaudhuri, Travelling Inspector, Department of Agriculture, Bengal, which is full of the most minute particulars about soil, cultivation, and treatment. Mr. D. R. Wallace,

in his interesting book "The Romance of Jute," gives a most vivid narrative of the progress of the Indian jute mills from their start, and I have made use of his figures as being reliable and authentic. Finally, I am indebted to Messrs. Johnston and Hoffman, and the *Empire* newspaper, Calcutta, for the photographic slides I am going to show to you to-day. With this short explanation I will proceed with my subject.

The early history of jute lies in obscurity. It may have been cultivated in a small or large way centuries ago, and, personally, I have no doubt it was—for the reason that the natives of India are so conservative in their ways that what we may have thought was a beginning in the eighteenth century may have been as ancient as some of the temple ruins one sees or reads about in various parts of India. As a pot-herb the leaves are extensively used in India still, and I have the authority of the "Encyclopædia Britannica" for stating that jute leaves were used for this purpose from very ancient times, if the plant may be identified with the "mallows" mentioned in Job xxx. 4, "Who cut up mallows by the bushes." The same authority states: "It is certain the Greeks used this plant as a pot-herb, and by many other nations around the shores of the Mediterranean this use of it was and is still common." I might even suggest that tents used in ancient times by the great army of Mahomet were probably partly made of the fibre. I must not, however, labour this point, and if I start on the fact that we have some knowledge of jute being handled in a small way in 1746, and grown pretty freely in the northern districts of Bengal in 1804, we have at least an authentic starting-point. Mr. Finlow states that in 1829 some 20 tons of jute were exported from Calcutta, and although the next five years only saw a small advance, averaging under 600 tons per annum, the exports increased very considerably during the next ten or fifteen years, and eventually reached the very substantial figure of 80,000 tons in 1911–12.

In dealing with this subject to-day, I do not intend to give you any figures or statistics relating to the period after the war started, for, as you are aware, the whole trade was disorganised, and I will confine myself to figures ending with the 1912–13 crop. With a view to giving you some idea of the principal jute-growing districts, I have brought this map—kindly lent to me by Messrs. W. F. Malcolm and Co.—which will give you a far better idea than any description I could give you without it. You will observe that the principal districts in which jute is grown are Mymensingh, Rungpur, Tipperah and Purnea. To those engaged in the trade, however, other districts are equally well-known, and I thought it

ACREAGE UNDER JUTE CULTIVATION, 1912.

Bengal and Cooch Behar.		East Bengal and Assam.	
Balasore	3,400	Backergunge	29,000
Bhagalpore	3,150	Bogra	130,000
Burdwan	15,000	Cachar	320
Champaran	900	Chittagong	300
Cuttack	12,000	Dacca	188,000
Darjeeling	5,000	Darrang	1,800
Hooghly	60,000	Dinajpore	116,800
Howrah	25,000	Faridpore	150,000
Jessore	165,000	Garo Hills	4,600
Khulna	38,100	Goalpara	46,000
Midnapore	11,000	Jalpaiguri	94,800
Murshidabad	40,000	Kamrup	5,800
Muzaffarpur	1,400	Lakhimpur	130
Nadia	91,000	Maldah	38,000
Purnea	270,000	Mymensingh	756,000
Sonthal Parganas	7,500	Noakhali	26,000
24 Parganas	89,200	Nowgong	800
Cooch Behar	32,750	Pabna	220,000
		Rajshahi	80,900
	870,400	Rungpur	290,000
		Sibsagar	200
		Sylhet	36,000
		Tipperah	268,000
			2,483,450

Total acreage 3,353,850

might be of advantage to give you the official group of forty-one districts with which we are all more or less familiar. They are shown with the area under jute apportioned to each in 1912-13.

The total figures, substantial as they are, only represent about 5 per cent. of the 60,000,000 acres annually cultivated for other products in the province of Eastern Bengal and Assam. The usual custom is to estimate the outturn for the season at 15 maunds per acre or 3 bales of 400 lb. per bale, and on the whole the system has come out with a moderate degree of accuracy. It is, however, impossible, in the absence of a survey, to arrive at correct figures, and we must wait for some years before that desirable end can be attained. Meantime, the present system conduces to a very healthy gamble in Calcutta and London, which gives those engaged in the trade an annual opportunity of making or losing large sums of money. Apart from this, climatic conditions play a prominent part. You may have a large area sown without obtaining a large crop if the monsoon is fitful or deficient, and *per contra* a moderate area under favourable climatic conditions can yield a crop that exceeds all expectations and calculations. An unenviable post in connection with jute is that of Director-General of Agriculture in Bengal, who alternately comes in for the loud curses of the "bear" or the silent blessing of the "bull," or *vice versâ*.

Let me now proceed to enumerate shortly the various classes of jute. There are two principal species of jute, *Corchorus capsularis* and *Corchorus olitorius*. The former is easily distinguished by its round pods, while the latter has long cylindrical pods. (Fig. 1.) *Capsularis* is almost exclusively grown in the northern districts, while *Olitorius* is extensively cultivated in the Hooghly and 24 Pargana districts and in Western Bengal. This latter species has the advantage of being more easily decorticated than *Capsularis*, which is of considerable advantage. On the other hand, *Capsularis* plants can stand submersion better than *Olitorius*, and, generally speaking, are less easily affected by adverse climatic conditions. Notwithstanding these peculiarities, it has been proved beyond all doubt that each of these principal species of jute would yield a different class of fibre if subjected to different conditions of soil and climatic influences. I will not go deeper into the question of strength and colour, for this is also so dependent on circumstances that reliable data are not obtainable. I may, however, usefully add that the best jute is produced on the higher lands, especially if well cultivated. Jute on the lower lands is generally cut before it has time to ripen or reach maturity, owing to fear of floods and loss of plant. Another species of jute is grown chiefly on the Madras side, called *Hibiscus cannabinus*, known on this side as "Bimli" jute. It is in every respect inferior to the Bengal jute, being shorter and coarser. It has, however, come into considerable requisition in late years, owing to an improvement in the treatment and packing, and also, I believe, on account of its comparative cheapness as compared with Bengal jute. Its production has also considerably expanded during the last five or six years.

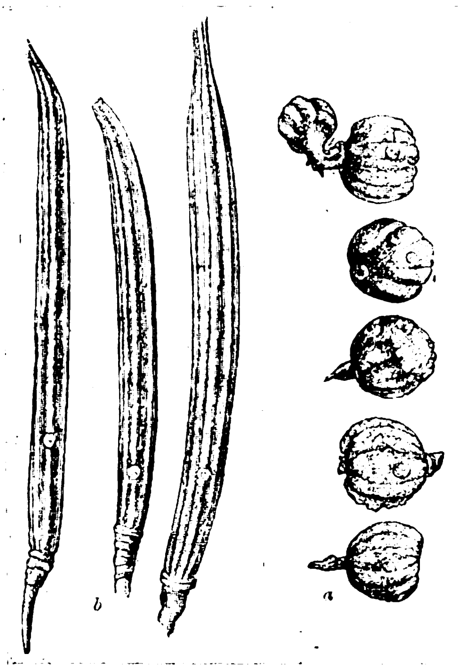

FIG. 1.—CAPSULES OF JUTE PLANTS.
a, *Corchorus capsularis*; *b*, *C. olitorius*.
(*Reproduced from the "Encyclopædia Britannica," by permission of the Encyclopædia Britannica Company, Ltd.*)

The preservation of seed has received considerable attention of late years, helped by experiments conducted by the Government Department of Agriculture. In former years seed was raised from stunted plants on the outside edges of the jute fields, and naturally, being obtained from the poorest plants, proved disappointing. As in dealing with many other industries in India, the ryot pays insufficient attention to keeping seed grown from the healthiest plants, with the result that, year

FIG. 2.—PLOUGHING THE JUTE FIELD.

after year, the same old seed from the same old and weak plants has been preserved since the original bagful came out of the Ark! A little more care and an interchange of seed would materially increase the outturn and improve the quality of the jute as well.

It would take a much longer time than I have to-day to deal at length with the intricate question of soil and its treatment, and I will merely state that jute in India can be grown in almost any soil which has a good depth and has the necessary material required to fertilise it. On the alluvial soils in Eastern Bengal, where the rivers and khals leave a rich deposit annually,

FIG. 3.—FULL-GROWN JUTE.

FIG. 4.—CUTTING JUTE.

jute grows freely without any artificial help. On the other hand, the higher lands are heavily manured and yield heavy crops, not only on this account, but also owing to the fact that jute grown on the higher lands is immune from floods and has a much better chance of ripening. An ample rainfall is, of course, an essential to supply moisture, and later on steeping water for "retting" the plant when cut. Rainwater is generally considered more beneficial than irrigation, however ample.

To take you through the various stages of ploughing, sowing, harrowing, weeding, would occupy far more time than I have at my

FIG. 5.—CUTTING JUTE UNDER WATER.

disposal, and I must shorten the description as much as possible. Early in February the ploughing commences on the low-lying lands and continues to the beginning of May on the higher lands. Fig. 2 will show you the ploughing.

The process is crude enough, and it is difficult to believe that at a later stage, when the plants appear in full growth, a scraping of the earth with a crooked piece of stick drawn by a pair of emaciated bullocks could possibly have produced such a result. After the land is ploughed and pulverised the seed is sown broadcast and in quantities of from 6 lb. to 12 lb. an acre. After this has been done the ground is raked or harrowed and the plants allowed to germinate and grow to a height of a few inches, when the rake is again used to stir up the soil and stimulate the growth of the plant. This raking process is also useful in keeping down the very healthy crop of young weeds that come up with the germinated plant. At times they grow quicker than the plants, and are very troublesome. At a later stage weeding and thinning take place, and then the plants are allowed to reach maturity without further interference. Fig. 3 shows you full-grown jute.

The period for reaping varies according to circumstances and climatic conditions. On the lowlands cutting starts about the end of June; if there is any danger of the fields being flooded, cutting is commenced even earlier. Early-cut jute is never very satisfactory; it is usually immature, short and mossy. Here is jute being cut under circumstances which I have just described under normal conditions (Fig. 4); while Fig. 5 is meant to show the conditions under which lowland or flooded jute is secured. The process of "retting," as shown in Fig. 6, usually takes anything from ten to thirty-five days, according to the time of year. In July and August, when the temperature of the water is high, the process is quicker and the jute is ready for further handling, but in September and later months it takes quite a month to "ret" the plants. The experienced grower can tell at once when the "retting" process is complete, and then the plants are taken out of the water, the fibre extracted, washed and dried—and here again climatic conditions play a prominent part. Heavy and continuous rain prevents the drying, and very often, as we know, makes the crop late in coming to market. When the jute is sufficiently dry, it is rolled up in drums and sent to the nearest market or sold locally to small dealers, who take it away to some of the large centres in country boats and dispose of it at a considerable profit. Many of these country boats make their way down to Calcutta and sell their cargoes to the jute mills along the River Hooghly.

The principal jute markets are at Naraingunge, Serajgunge, Chandpur, Madaripur, Jagannathgunge, Purnea, Julpaiguri, Koostea and Goalundo, and during the season these centres present scenes of animation and extraordinary activity. Here is a general view of Naraingunge, the principal one, which gives you some idea of the size. (Fig. 7.) It is conveniently situated on the bank of the river, which is alive with craft of every description.

At these great centres you will find not only native merchants purchasing jute, but also firms managed by Europeans buying for Calcutta mills, and Calcutta merchants buying suitable qualities for baling in Calcutta for export. A very considerable quantity of jute purchased at these up-country markets is resold to balers in Calcutta.

The transport of jute from the producing districts to Calcutta has been considerably accelerated. In the earlier days of the industry the jute came down packed in drums by country boats and river steamers, but in later years the railway has carried by far the most of it, the proportions being approximately as follows in 1912:—

By rail	about	20,000,000	maunds
By steamer . .	,,	6,000,000	,,
By country boats .	,,	6,000,000	,,
By road. . . .	,,	1,250,000	,,

The use of jute-presses in the jute districts has greatly facilitated transport. In 1891 there were only nine or ten presses in Eastern Bengal, whereas the number is now about 130. These presses are used to pack what are known as "Cutcha" bales, containing three to three and a half maunds, and are usually sold to mills and large balers. The exported bale to Europe and other countries is of a fixed standard of five maunds, or 400 lb. The packing is chiefly done in Calcutta, where the pressing-houses have increased from fifteen or so in 1885 to about forty at the present date. Fig. 8 shows the inside of a jute-press at work. Adjoining the press-house are large stores or "go-downs," where jute is assorted into the various standards required for the European market. The packing business was formerly in the hands of Bengalis, but with two exceptions this part of the trade has passed into the hands

FIG. 6.—RETTING JUTE.

of Marwarris, outside of course of the European balers, such as Ralli Bros., Duffus, Steel, and the Chittagong and Naraingunge companies.

Before leaving this part of my subject, I may just say a few words on the cost of production and the prospects of increasing the area. Mr. Chaudhuri, in his book on "Jute in Bengal," written in 1907, puts the cost of production at Rs. 3/8 per maund, but I fancy this is far below the cost of the present day, for, as with all other products, enhanced prices generally lead to an increased cost of production. It is rather difficult to account for it except in this way. Formerly, when the area was smaller, the ryot could conveniently manage to cultivate and harvest his little plots with his own family,

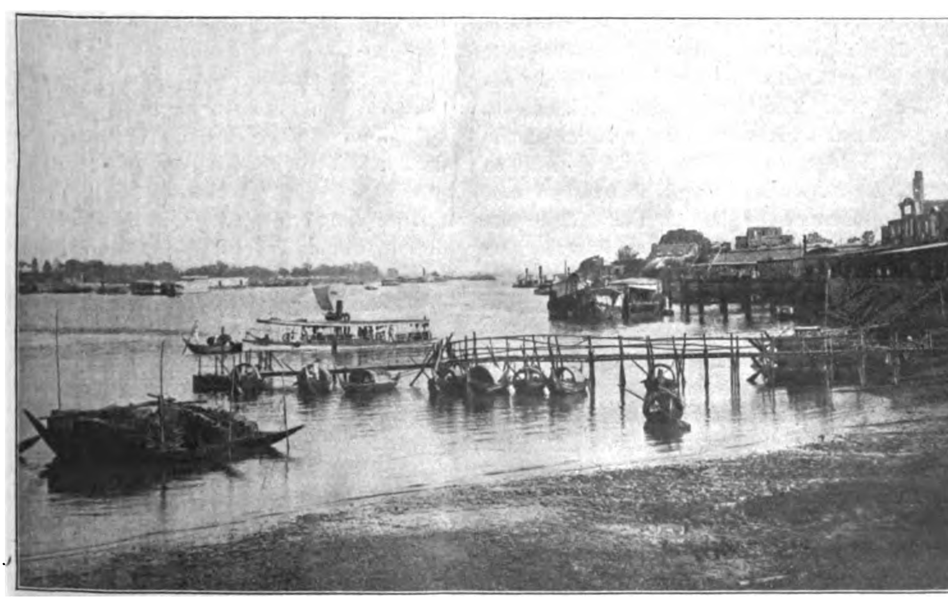

FIG. 7.—GENERAL VIEW OF NARAINGUNGE.

without incurring extra expenditure for outside labour; but with the increased demand and higher prices ruling, larger areas have been cultivated, necessitating the use of hired labour, which has materially added to the cost. This leads me to deal with the prospects of increasing the area.

It is, of course, quite a simple matter to point to the vast expanse of country available for jute cultivation, looking to the fact that jute only covers an acreage of 3,000,000 acres out of some 60,000,000 acres in cultivation in the province of Bengal and Assam. There is no lack of suitable land, especially in Assam, but the labour question absolutely prohibits expansion. It has been attempted at various periods by European firms, who have experimented with labour-saving implements; but, so far as I am aware, none of these has proved successful, and we must fall back on our old friend, the ryot. That the existing area could be made to produce a very much larger crop has been proved beyond doubt. A more scientific system of cultivation and greater care in the selection of seed and the application of fertilisers on higher lands would probably double the outturn per acre in a normal year.

Climatic conditions will always remain an important factor in determining the annual outturn on any given area. I therefore venture to state that while another million acres could be added to the existing area, so far as suitability of land is concerned, the question of labour will bar it; and we can only rely on improved agricultural methods to increase the crop. It has been stated by experts in jute that the crop has seriously deteriorated during the last ten years. The statement is confirmed by many spinners with whom I have discussed the subject. I do not think it is at all difficult to account for it. It is, I think, due to the fact that the enhanced value of the article has induced the ryot to cultivate more jute than he can handle, and that the large crop now being produced is beyond the limit of those who are engaged in it. I do not think the plant has deteriorated at all, but rather that the rush to grow it with insufficient labour has gradually, in late years, led to carelessness in the harvesting and curing of it, consequent on the desire to get it on to the market and secure the higher prices now ruling. I think this has also something to do with the excessive moisture found in the fibre in late years. The same time and trouble are not expended in drying it properly, and while the ryots who grow the jute may and do, as a rule, deliver it dry to the middlemen, the latter, especially the smaller dealers, are known to water it freely in order to increase the weight. This has been proved beyond doubt, and evidence was obtained some years ago that quite 75 per cent. of the jute reaching the Serajgunge markets was freely watered and sanded. It is difficult, indeed, almost impossible, to put an end to this practice, as the jute passes through so many hands, and I very much doubt if legislation, urged and even contemplated a few years ago, would have put a stop to it. Wet-packed jute quickly deteriorates in colour and strength of fibre, and it is not unusual to find bales of jute reaching this country with heart damage varying from 2 to 30 per cent., or even more.

Time will not permit me to give you an outline of how jute is commercially dealt in, nor am I able with the limited time at my disposal to give you anything but a very brief idea of the many uses it can be put to. Normally, it is the cheapest fibre for providing bags to carry the produce of nearly the whole world. It carries all the valuable wool and grain from our Australasian colonies, from America, South America, and, indeed, any quarter of the world where grain and oil-seeds are produced. It is used for the internal carriage of goods in every part of the globe, for covering cotton bales, tarpaulins, carpets, and even shirts are made from it in Dundee. Hem Chundra Kar, in his official report on jute issued many years ago, gives the following interesting varieties of uses to which jute was put in the Midnapur district: (1) Gunny bags; (2) string, rope and cord; (3) *kampa*, a net-like bag for carrying wood or hay on bullocks; (4) *chat*, a strip of stuff for tying bales of cotton or cloth; (5) *shika*, a kind of hanging shelf for little earthen pots; (6) *dulina*, a floor cloth; (7) *beera*, a small circular stand for wooden plates, used particularly in the poojahs; (8) brushes for painting and whitewashing; (9) *ghunsi*, a waist-band worn next to the skin; (10) *gochh-dari*, a hair-band worn by women; (11) *mukbar*, a net-bag used as a muzzle for cattle; (12) *parchula*, false hair worn by players; (13) *rakhi-bandhan*, a slender arm-band worn at the Rakhi-poornima festival; (14) *dhup*, small incense sticks used at poojahs; (15) *dola*, a swing on which infants are rocked to sleep. It has, as you know, been extensively used for sandbags in the present war. It has no real rival, and is not likely to have as far as we can see.

In the early eighties experiments were made in jute culture in Egypt, and in the Dundee Trade Report of March 23rd, 1881, the following statement appears: "Some samples of jute

grown in Egypt are being shown here. Reports on quality are varied, but, considering it is a first attempt, on the whole satisfactory. It proves beyond doubt that Egypt is capable of producing this material, and for the trade of this district this is a matter of great importance, as having the fibre grown near at hand will enable our manufacturers to compete more successfully in all markets with the Indian mills." But the project does not appear to have gone much further, no doubt on account of the cost of labour making the cost of production impossible.

A few years back *Textilose* made from paper was exploited as a substitute, but it has turned out unsuitable owing chiefly to the fact that it cannot stand immersion in water without falling to pieces. The Germans have lately exploited a fibrous plant (*Epilobium hirsutum*), which they assert will oust jute from the German markets. I very much doubt this. Even if it had the spinning qualities of jute they would find the cost of production so prohibitive that it could never compete with a fibre grown under the same conditions as jute.

I will now proceed to give you a short history of the manufacturing trade in jute. It has, like the raw material, an obscure early history, but has made up for it by coming very rapidly to the front and assuming an important position in various parts of the world. In relating the progress of jute-spinning and weaving by machinery we have ample data to go upon, and while we are unable to trace back the earlier history of hand-loom spinning in Bengal, we have records of its existence in the earliest days of our entry into that country. In this connection I cannot open the history of jute-spinning and weaving more appropriately than by giving you a paragraph from Dr. Forbes Royle's "Fibrous Plants of India," published in 1855, in which he quotes a letter from a Calcutta merchant. This is reproduced in Mr. Wallace's "Romance of Jute," and is as follows: "The great trade and principal employment of jute is for the manufacture of gunny *chuts* or *chuttees*, *i.e.*, lengths suitable for making bags. This

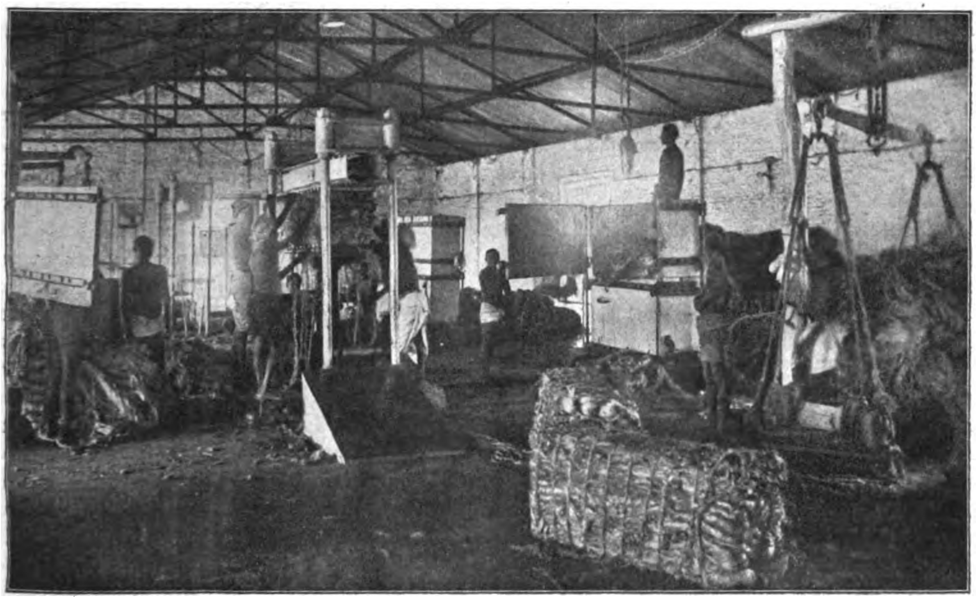

FIG. 8.—PRESSING JUTE (LASHING).

industry forms the grand domestic manufacture of all the populous eastern districts of Lower Bengal. It pervades all classes and penetrates into every household; men, women, and children find occupation therein. Boatmen in their spare moments, husbandmen, palankeen carriers, and domestic servants; everybody, in fact, being Hindus—for Mussulmans spin cotton only—pass their leisure moments, distaff in hand, spinning gunny twist. Its preparation, together with the weaving into lengths, forms the never-failing resources of the most humble, patient, and despised of created beings—the Hindu widow. Saved by law from the pyre, but condemned by opinion and custom for the remainder of her days literally to sackcloth and ashes and

the lowest drudgery in the very household where once, perhaps, her will was law, this manufacture spares her from being a charge on her family; she can always earn her bread. Amongst these causes will be discerned the very low prices at which gunny manufactures are produced in Bengal and which have attracted the demand of the whole commercial world. There is, perhaps, no other article so universally diffused over the globe as the Indian gunny bag. All the finer and long-stapled jute is reserved for the export trade, in which it bears a comparatively high price. The short staple serves for the local manufactures, and it may be remarked that a given weight of gunny bag may be purchased at a similar weight of raw material, leaving no apparent margin for spinning and weaving."

The two slides I now show will give you an idea of what the quotation I have just read so vividly describes. (Figs. 9, 10.) I give you one showing a portion of a modern mill: you will see at a glance the enormous strides that have taken place. (Fig. 11.) The entry of Dundee into the trade goes back to the year 1838, but this attempt was neither serious nor successful. However, the experimental stage of inexperience and failures gradually disappeared, and the next fifteen years saw spinning and weaving of jute carried on in Dundee with success and profit. In 1855 a beginning in spinning and weaving was made in Calcutta in earnest, and a mill was erected at Rishra, near Serampore, which produced an outturn of some eight to ten tons a day. This mill was on a piece of land which is at present occupied by the Wellington Mills, and if the spirits of the Dundee mechanics who were the pioneers of the first mill were permitted to roam about that part of the world now, and cast a glance across the River Hooghly to Tittaghur, they would indeed be surprised at the wonderful change. Four years later the Barnagore jute mill came into existence and seriously commenced cloth-spinning on an extensive scale, and this same company is still going strong. It has had a varied career, but, on the whole, I do not think that any of its original shareholders has reason to complain of the investment! The business part of the work was managed, and managed successfully, by the late Mr. Thomas Duff, founder of the firm of Messrs. Thomas Duff & Co., Ltd., who subsequently launched out on his own account, and the group of mills at Tittaghur are a standing monument to his enterprise and great success. In 1862 two more mills came into existence, the Gourepore and Serajgunge. The former is still in existence, and is one of the largest mills on the Hooghly. The Serajgunge mill, erected at Serajgunge in order to be near the producing district for the raw material, was never a great success, and was finally destroyed by an earthquake in 1897, and its machinery and plant transferred to the Delta mills, near Calcutta. These mills reaped a great harvest of prosperity up to the year 1875. This attracted public attention, and there was a rush to erect new mills, no fewer than thirteen companies making their appearance, amongst them the Hastings mill, which Messrs. Birkmyre erected with machinery transferred from their Gourock sugar factory. The inevitable result followed, and the next ten years was a period of depression owing to over-production. This led to a check in the building of new mills, and only one was added in the next five years. But in 1885 four more mills were added to the list, which remained stationary until ten years later, when extensions to existing mills and new mills increased the number of looms considerably. During this period considerable attention was paid to the export trade in gunnies and hessians, and great progress was made. Standards were established on a firm basis and the trade generally put on a sound footing. The marked improvement in the manufacture of hessians enabled the Calcutta mills to compete successfully with Dundee in the American trade, and questions in the House of Commons were frequently raised, hinting at a form of slavery in Calcutta. Eventually the Dundee member paid a visit to Calcutta, and from that date the agitation ended. Since 1895 the expansion has been rapid, in spite of periods of depression and gloom. At the present time there are some forty-six mills on the River Hooghly, with a total of close on 40,000 looms, employing very nearly a quarter of a million Indian labourers, having a capital of over £13,000,000 (including debentures and reserves), and using three-quarters of a million tons of coal per annum. The prosperity of the industry at the moment is extraordinary, and it is not easy to see what can happen to shake this trade, which is being conducted on the soundest commercial lines.

Figs. 12 and 13 will give you some idea of a modern jute mill, and of the provision that has to be made in housing the large labour force employed.

Before concluding this short history of the growth of the jute trade, both in the raw and manufactured article, I may be permitted to

give a few comparative figures to bring the present position into a more concise perspective.

The value of raw jute exported in 1829 was approximately £500; in 1913 it was close on £20,000,000. The outturn of the manufactured article in 1855 was about 8 tons per day; now it is getting on for 3,000 tons per day, or nearly four times as much as Dundee produces. The Calcutta mills, from an annual consumption of a few thousand bales in 1855, now take over five million bales, and it does not appear likely that that is the end of it; for new projects are in the air, and it is quite likely that the next few years will see a further expansion. The following list of jute-spinning and weaving mills in all countries is approximately correct, and will show you the importance of this great industry:

United Kingdom	52
Germany	36
Austria-Hungary	17
France	32
Italy	25
Belgium	23
America	16
Russia	7
Sweden	5
Denmark	2
Switzerland	2
Holland	2
Brazil	2
Norway	1
Rio	1
Argentine	1
Total	224

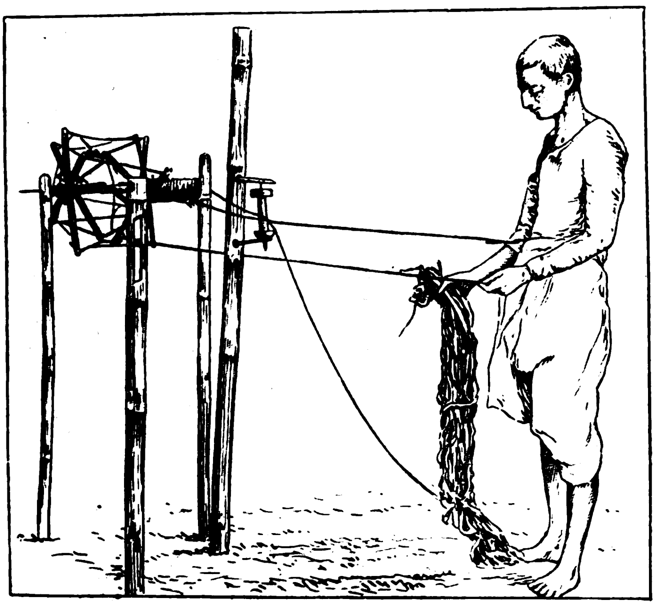

Fig. 9.—Native Hand Spinning.

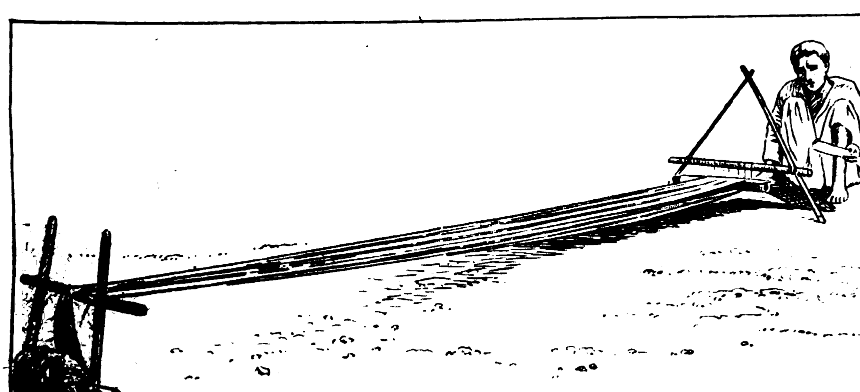

Fig. 10.—Native Loom.

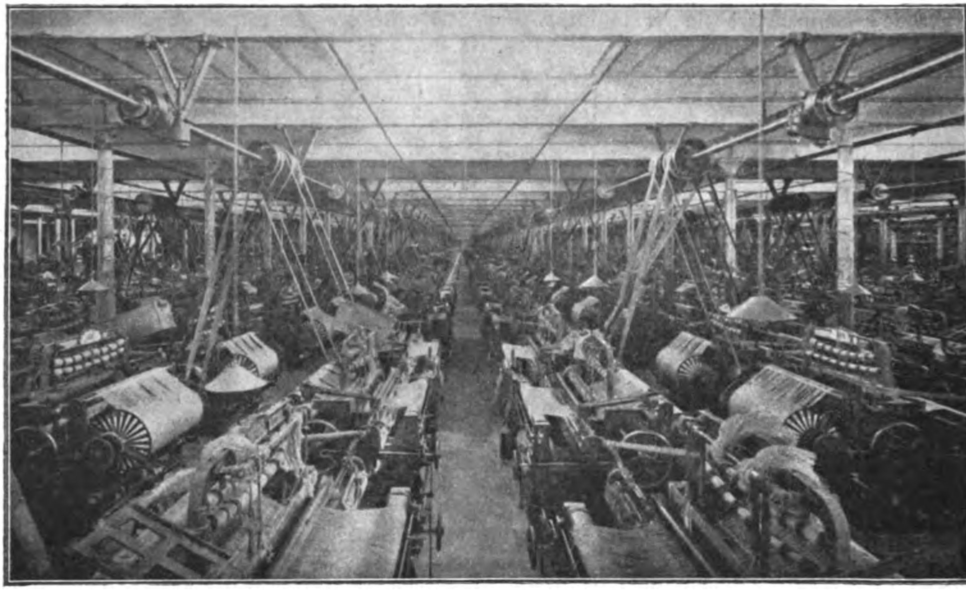

FIG. 11.—FACTORY (WEAVING).

In conclusion, you must grant me your indulgence for a few minutes more if I turn your thoughts to other vital considerations in connection with this very important industry. I have endeavoured to show you the value of this commodity to India and the Indian ryot, more especially in those districts where jute is grown. The extensive use to which this fibre is put and the enhancement in price have enabled the grower to extricate himself from the usurious kyah or moneylender, and generally to improve his condition materially. As in most products which are in demand, the cost of production, as shown in a previous part of my paper, has risen considerably, but there is still a substantial margin of profit, and that will, I think, continue to benefit the grower more and more as time goes on. In former days the

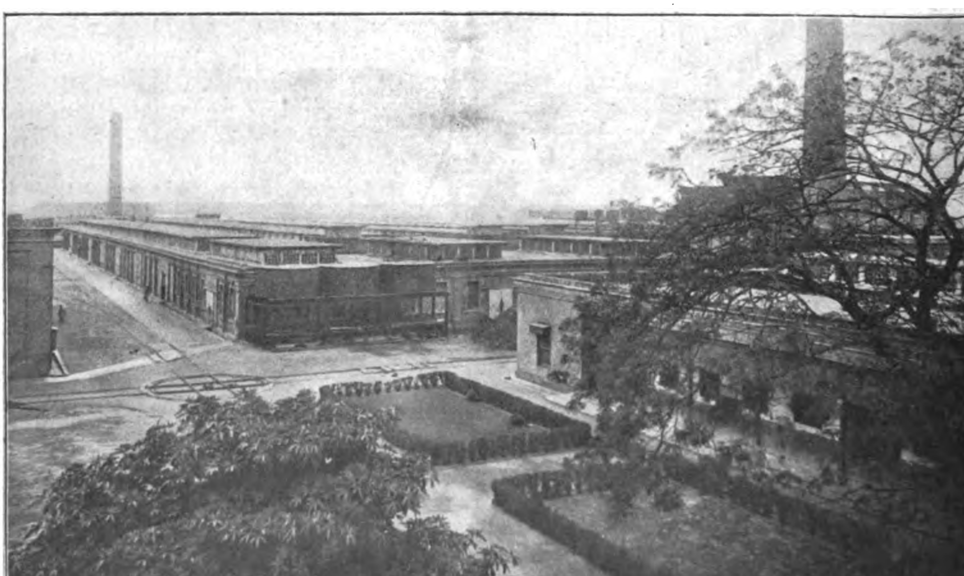

FIG. 12.—GENERAL VIEW OF JUTE MILL.

cultivator was obliged to grow jute and dispose of it at a fixed arbitrary rate from which he got no benefit, and at times not a living wage; but the industry, like many others, has undergone great changes and the old order of things is gradually passing away, to the distinct advantage of the ryot, and incidentally of the country. Jute, as you are all aware, is a monopoly of Bengal, and as such could be much more advantageously handled than it has been in the past. Every country in the world has up to now been allowed to have its share of it on the same terms and conditions as we in this country get it. In my humble opinion, this is altogether wrong. In saying this I may be treading on the toes of Free Traders, jute could be shipped from Calcutta to Hamburg direct except in a "Hansa" liner. There was evidence that a few years' time would see Germany purchasing jute from natives of India direct with Hamburg arbitration, and, indeed, I am not at all sure that a beginning had not been made in this direction. They at the same time secured a market for their manufactured goods that precluded serious competition from Dundee or Calcutta by a system of tariffs, and went so far as to dump their excess production on our markets when it suited them. Surely it is high time all this was stopped, and that we opened our eyes to the fact that we have the monopoly of a raw material that cannot be grown success-

FIG. 13.—GENERAL VIEW OF COOLIE LINES.

but I cannot help thinking that the day of Free Trade as politically understood is now a thing of the past. Contrast our action for one moment with that of the only German colony that grew any fibre at all, *Sisal* hemp, in East Africa. Their conditions were that the fibre should be grown under German supervision, decorticated by German (Krupp's) machines, shipped to Germany only in German ships, insured in a German company, sold by German brokers and subject to German arbitration! I do not see how they could have drawn the net much closer. I have, for many years before the war broke out, watched the position as regards jute. This same process was being exploited, and they had already gone as far as securing that no

fully elsewhere, and acted accordingly. I am familiar with the arguments that can be brought against this view; but if this great war has proved anything so far, it has amply proved that we have lost golden opportunities of benefiting our own subjects and our own colonies, owing to our failure in grasping the insidious machinations of German traders. With the mask thrown off by our enemies, and the actual position brought to light in a manner which cannot be controverted, are we again to lose an opportunity that may never return by adopting a fatal "wait and see" policy, or are we to gird our loins and prepare ourselves against the trade invasion that will assuredly take place when this war is over? Jute will

be one of the most urgent needs, and every effort will be made by Germany and Austria to buy it on the old terms. Are we going to sit down and allow them to do so with an article of which we hold the monopoly, and one that neither of these countries can do without? The port of Calcutta has been enlarged out of all recognition to accommodate the increased trade in exports, chiefly jute, which is the most valuable export from Bengal. Large docks have been built and will probably have to be doubled. The port of Chittagong was opened mainly to provide for the export of jute. Many millions have been spent on these improvements, and yet countries who have not contributed one penny towards them are, under the favoured-nation clause, benefiting as freely as the country that is paying the interest on the colossal outlay expended on these ports. I think it is time that some different system of handling Bengal's valuable monopoly of jute were brought into action, and that those who wish to have a share in this great trade should be made to contribute to the cost of the ways and means of handling and transporting it. If we do not act, and act promptly, it is easy to see what will happen. After this war is over, if nothing is done, Germany and Austria will receive our jute on the same terms as British subjects, without contributing a farthing towards the heavy expenditure and consequent taxation that is imposed on the country that produces this monopoly. Ought we not now to realise this and have an effective remedy? I think so.

DISCUSSION.

THE CHAIRMAN (Sir John Hewett, G.C.S.I. C.I.E.) said he needed no authority beyond the applause with which the paper had been received to enable him to express the appreciation of the audience for the manner in which the author had given all the information which was available with regard to the cultivation and the manufacture of jute, and the uses to which it was put. The illustrations had been most useful in showing the system of cultivation and the old, crude methods of spinning and weaving, and the modern machinery that had brought the industry to its present high level. An industry the total export trade of which amounted to 40 millions sterling a year was something to be proud of. Like many other things in India—the posts, railways, telegraphs, etc.—the great industry was entirely due to the capital and enterprise of the British. That was a fact some people were very apt to lose sight of, but one that should always be borne in mind. He was afraid that he knew very little about the cultivation and manufacture of jute, as he belonged to a part of India where no jute was to be found; it was only by a happy chance that once, when travelling in Eastern Bengal, he was able to see jute under cultivation and the methods in the villages by which it was spun and woven. Later on, when he was in charge of the Department of Commerce and Industry, two matters came before him in connection with jute—one a comparatively small one, and the other of real importance. The first related to the question of imposing a small export duty on jute in order to provide funds for the Calcutta Improvement Trust; and the second, the very important question of the "Watering of Jute" Bill. He knew that at the time in Calcutta there were very varying opinions as to the merits of this. There was no doubt that, by an admixture of water and sand, jute had been very seriously adulterated with great harm to the trade, but he was unable to see any means by which legislation could be effectively applied to stop the process of adulteration; it seemed to him—and it was the view eventually taken by the Government of India and the Secretary of State—that the more effective means of preventing adulteration was for the trade to take the matter into their own hands. He believed that action of the trade had had the desired effect, and that there was nothing like the adulteration there used to be. Mr. McLeod had referred to the manner in which the Government allowed jute to be exported to Germany without any charges whatever for the benefit of the State or local funds. Throughout the history of our dealings with Germany he thought it would always be found that the struggle had always been to prevent the Germans robbing us of our commercial advantages. In the Middle Ages, when Englishmen were in need of something obtainable only in Germany, the Hanseatic League always made them pay through the nose for it, and in the present day that process flourished as much as ever. On the other hand, we in the most lamb-like manner offered all the things we had to Germany in the cheapest possible market. We allowed them to resort to all those processes to which Mr. McLeod had referred, and we looked on while State-protected industries were dumping their products on our markets without making any efforts to protect ourselves. Whatever our principles were before the war, whether we were Free Traders or Tariff Reformers, or were satisfied that neither of those dogmas was quite sufficient to bring us salvation, we all felt quite sure that in the economic world, as well as in social and political matters, we should have to revise our old ideals. Therefore he had no hesitation in saying that he was personally a very strong supporter of the author's view that we ought to get the Government to put an export duty on jute. But he would go a great deal further. He did not see why, while our allies and dependencies were entitled to get our raw products on the best possible terms, countries like America, which chose to put a very heavy import duty on the manufactured articles which we sent to them, should have raw jute without an export duty. Although

he would apply as much restriction as possible to German trade, in this particular instance he would apply it to other people too. As Mr. McLeod was the Chairman of the Indian Section of the London Chamber of Commerce, he should now set about organising arrangements by which the Government should be forced to consider the question. He should also give his attention to any other matters in which it appeared that he could effectively do good to British and Indian trade at the expense of German trade.

SIR WILLIAM DUKE, K.C.S.I., K.C.I.E., expressed his appreciation of the comprehensive paper. He himself had had a fairly close connection with jute during a great part of his existence, having lived within sight of it when it was growing, and within scent of it when it was *retting*—and the scent was not exactly that of the honeysuckle. There was no question of the extraordinary value of the industry. It was worth annually from 20 to 30 millions sterling to the peasants of Bengal, Assam, Berar and Orissa, and supported in addition something like a quarter of a million factory operatives and their dependents. What it exactly produced for shareholders, agents, dealers, and shippers, he did not know, but it was something very handsome indeed. The author seemed to think that the position was so stable as not to be seriously threatened; he feared none of the competitors which had yet appeared. It was to be hoped he was right, but the future success of a monopoly industry like jute depended entirely upon the cost of production being kept stable and low. A textile which was principally required for bags could undoubtedly be produced at a price. If there was no competitor it was simply because jute at present was able to undersell every competitor. How long that might continue with the rising cost of production it was hard to say. Mr. Chaudhuri, five years ago, estimated the cost of production at three rupees eight annas a maund. but it was probably now over four rupees. With the extension of cultivation and the increasing prosperity of the cultivator more and more resort was had to hired labour, and the price of such labour in Bengal was now high; the rates in the neighbourhood of Dacca and Serajgunge had recently been as high as a rupee a day. Were there only the natural and inevitable increase in cost of production to be feared, he certainly thought that jute might look forward for a long time to being able to hold its own, but one had to consider the extraordinary fluctuations of raw jute. Within a period of two to three years he had known the price of raw jute to vary between 200 and 300 per cent.; he had known it vary in Calcutta from a little over five rupees to fifteen rupees a maund within a comparatively short time. That was not a healthy condition. An excessive price for the raw material must act as a bonus on the production of competing fibres. It might be said that all agricultural products were subject to fluctuations, but he knew none which were subject to such great fluctuations from such comparatively small causes. These fluctuations occurred with variations of perhaps not more than 10 per cent. in the crop. It had been said that the great variations were largely due to gambling in the product in Calcutta. He could not suggest a remedy, but one had to be found. There were only about fifty jute mills in Bengal and the bulk of the raw produce was worked up in the country, and the fifty jute mills were in the hands of a smaller number of managing firms. The extraordinary fluctuations were not good for the cultivator, and did not tend to a steady increase in the area cultivated. It was not good that the Indian cultivator should be paid for his crop one year twice as much as it was worth and next year not get a remunerative price. About nine years ago he was in Orissa, a country that cultivated very little jute, but was capable of cultivating a good deal. In 1905, or perhaps it was 1906, there was a great jute boom in Bengal, the price going up to something like ten rupees a maund. This appealed to the Orissa cultivator, and next year the area cultivated was greatly extended, but that year there was a good crop all over the country and prices fell, and the Orissa cultivator was offered six rupees for a crop that in the previous year would have fetched ten rupees. He decided to hold up his jute, but in the end had to let it go at six rupees, and for some years that was the end of increasing jute cultivation in Orissa. The fluctuations had prevented the release of the cultivator from the hands of the moneylenders. The people who really controlled the jute trade were comparatively so few that it ought to be quite possible for them to find a remedy, and he thought it urgent that they should do so.

MR. J. E. WOOLACOTT thought it was well that the importance and value of the jute industry should be better known in this country than they were at present. It was a modest industry. If Calcutta were in America there would be a "Jute King," and probably Mr. McLeod himself would occupy that exalted position. In India the jute-mill owners were content to go on quietly amassing their millions, to the great glory of Scotland and to the benefit of Bengal. The industry was of such great importance to Bengal that if it were removed Calcutta would sink to the level of Bombay and other minor cities in India! But, as Mr. McLeod said, there was no apprehension on that point. The industry was flourishing, and if Mr. McLeod's fiscal policy was carried out it would no doubt flourish more than ever, because the raw material would be cheaper—and perhaps Dundee would be allowed to share in that great advantage. Everybody was in favour of preventing Germany from attaining the position she was about to attain when the war broke out, but there were other interests involved besides those of Germany and Austria—France and Italy, both of whom were large importers of jute, and also the interests of the cultivator in Bengal. In the end any decision come to must be based primarily upon the interests of the people

who produced the jute. He was quite in sympathy with the main object Mr. McLeod had in view, but the question was a very complicated one, and part of a very much larger question that would have to be solved at the end of the war. It would be a very valuable thing if the commercial bodies with which Mr. McLeod was connected would consider the matter very carefully and give those who were not so well versed in the subject some information on which to base a judgment.

Mr. L. R. Windham Forrest asked whether the author could supplement his remarks by explaining by what method jute was prepared for the market.

Mr. T. J. Bennett, C.I.E., in proposing a vote of thanks to the author, said that Mr. McLeod had shown that the subject was one of great human interest. For instance, he had shown that jute served as a swing for infants, as a rope for the neck of the criminal, and an excellent substitute for the penitential hair-shirt. In thinking of the deterioration of jute one recalled the tragedy of indigo. There were both superficial and fundamental differences in the economic conditions of jute and indigo, but the experience with regard to the latter should be a warning not to allow the deterioration in the quality of jute to continue. The readiest remedy was to ask Government to look into the matter, but it was a question which the leaders in the trade might far better look into for themselves. There was a time when, if so contested a question as preferential treatment of jute or any other product had been discussed in the hall of the Society, there would have been "wigs on the green." But there had been some very plain speaking that afternoon, and no protest had been raised, the reason being that nowadays anywhere, and at any time, anybody could say what he liked on economic questions. The attitude of the audience that afternoon on the question was unmistakably in favour of, at all events, approaching the question from a new point of view. Jute was a product favourably situated for having a place in a great scheme of Imperial preference. It was practically a monopoly, and our enemies were quite as eager to buy it as we were to sell it. He thought we should be justified in protecting our own interests by acting on the suggestions that had been made in the paper and the discussion. Mr. McLeod was a very influential man, and as Chairman of the Indian Section of the London Chamber of Commerce could undertake to see that there was adequate information available on the question. The whole subject of Imperial preference had to be gone into, and a solid foundation should be provided for future building. Sir John Hewett was particularly fitted to take the chair on such an occasion, because, as everyone in India knew, there was no man who could give a sounder opinion on a commercial subject. It had been a privilege to have him present, and in thanking him they would wish him God-speed on his journey to India, where he would be warmly welcomed. They wished him a pleasant journey and a speedy return to England, where he was doing such good work.

Sir Bradford Leslie, K.C.I.E., seconded the motion. He said he was one of the original engineers who constructed the Eastern Bengal Railway, which carried the greater portion of the jute, and at the time he was building the floating bridge across the Hooghly at Calcutta he was also officiating as engineer to the municipality of Calcutta. They had a large area called the "Reclaimed Square Mile," near the salt-water lakes, where they deposited the Calcutta sweepings, and he was struck with the fine quality of the mould that resulted, and the rank luxuriance of the weeds growing thereon; he cleared a small patch of the ground and planted some ordinary jute seed, which after a good rainy season grew 50 per cent. taller and twice the thickness of stem of ordinary jute. He did not pursue the matter any further at the time, but he believed there were millions of tons of such mould which might be utilised for fertilising the land on which jute was grown, and no doubt the municipality would be glad to get rid of the stuff. He hoped when the war was over the railways would be extended to facilitate the jute trade.

The motion was carried unanimously.

Mr. McLeod expressed his thanks for the vote. He was sorry time did not permit him to give Mr. Forrest a description of how jute was manufactured into yarns and cloth, but it would take a long time and he should be glad to do it privately. It was of peculiar interest to him that the vote had been seconded by Sir Bradford Leslie, as the first entertainment he ever went to in India was at Combermere Lodge, then Sir Bradford's residence, and now the residence of the superintendent of the jute mills in that quarter.

The Chairman also briefly thanked the audience.

The meeting then terminated.

SUGAR IN BRITISH GUIANA.

The sugar production of British Guiana and the possibilities of its expansion are discussed by Professor J. B. Harrison and Mr. C. K. Bancroft in the *Bulletin* of the Imperial Institute. The area under this crop, about 72,000 acres, is practically the same as it was eighteen years ago, while the average yields are somewhat higher. In normal years the Colony exports about 110,000 tons of sugar, 3,600 casks of molasses, 2½ million gallons of rum, and 12,000 tons of cattle food. If there were any certainty of sugar prices remaining remunerative, a very great extension of sugar cultivation would take place. It is estimated on very conservative grounds that the readily available area of land well suited for sugar-cane cultivation

in the eastern part of the Colony could produce 1,000,000 tons of sugar, while another 1,500,000 tons might be obtained on lands in the north-western districts. It is, however, admitted that scarcity of labour is an obstacle to expansion.

The sugar-manufacturing industry has been compelled by economic reasons to develop into one almost solely for large capitalists and companies. Still a few smaller cultivators pursue their business with fair success. Cane-farming is carried out to some extent by small proprietors and villagers, and its extension on a mutually profitable basis to the farmers and manufacturers is deemed very advisable. The average annual value of the cane products exported for the past twenty-three years has been £1,361,195. In the 'nineties, two-thirds of the sugar produced were exported to the United States, and almost one-third to the United Kingdom, the rest going to Canada; but in 1912 and 1913 about 70 per cent. went to Canada, 20 per cent. to the United Kingdom, and 8 per cent. to the United States.

MANUFACTURE OF COPRA IN BRITISH HONDURAS.

During the eight months, January to August, 1915, there were shipped from Belize 40,649 lb. of copra to the United States, and over 100,000 lb. to the United Kingdom, or more than the total shipments for as many previous years.

The meat of small coconuts, nuts broken in handling, and nuts that have sprouted can be profitably used in preparing copra, and, unless the local market price of first-class nuts exceeds $14 (about £2 17*s*. 6*d*.) per 1,000, such nuts can be used as well. Copra is worth 4 and 5 cents (2*d*. and 2½*d*.) a lb. in Belize. A thousand nuts should yield 400 lb. of copra, but the fancy prices that have been paid for coconuts during the past six years forbade consideration of making the article; as much as $30 (£6 3*s*. 4*d*.) per 1,000 has been paid for coconuts in Belize.

According to a recent report by the United States Consul at Belize, the manufacture of copra in British Honduras is not very expensive, the meat extracted from the nut being dried in the sun in five or six days, or under cover in the rainy season. The copra is then ready for bagging or shipment. The oil, if at all tainted, can be profitably used in soap manufacture. First-grade oil is used in making a cheap but wholesome grade of butter, which is now used extensively in European countries.

Coconuts are being extensively planted in British Honduras. It is a very profitable industry, even when nuts sell at $12 (£2 9*s*.) per 1,000. Copra manufacture is, however, a new venture in the country, but one that will, in the Consul's opinion, succeed and increase. No attention was paid to it until this year.

The immediate, even though slight, effect on trade will be the demand for bags and bagging.

OBITUARY.

Viscount Alverstone, G.C.M.G., LL.D., D.C.L., F.R.S.—By the death of Lord Alverstone at his house near Cranleigh, Surrey, on the 13th inst., the Society loses not only one of its most eminent Fellows, but one who had for many years taken a very keen interest in its welfare. Nor was he the first of his family to be associated with the Society's work, for his father, Thomas Webster, Q.C., the eminent patent lawyer, was one of its most active and useful members in the middle of the last century. Thomas Webster became a member in 1838, and took a leading part in the renovation of the Society, which ended in its obtaining its Charter in 1847. He was a member of the Society's first Council, and served on it until 1850, when a dispute about the administration of the Society's affairs arose between him and Mr. Henry Cole, the result of which was that Mr. Webster lost his seat upon the Council. He never after this took any part in the work of the Society, but he continued a member until his death in 1875.

Mr. Richard Everard Webster, as he then was, became a member of the Society in 1878. In 1883 he was elected on to the Council, and he remained on it, holding various offices, until the time of his death. He was Chairman in 1890, and during his term of office the Council was appointed the Royal Commission for the Chicago International Exhibition. In 1892 the by-laws relating to the election of the Chairman of Council were suspended by a General Meeting of the Society, in order to enable him to remain in office until the business of the Exhibition was concluded. This is the only case in which a Chairman has served for more than two years continuously. He was in America on the business of the Behring Sea Arbitration in 1893, and paid a visit to Chicago, where he remained some little time, and made himself extremely popular with the American executive as well as with the British exhibitors. His experience at Chicago led to his serving on the Royal Commission for the Paris Exhibition of 1900, and afterwards on that for the St. Louis Exhibition in 1904.

At the expiration of his term of office as Chairman, he was nominated by H.R.H. the Prince of Wales (King George V.) as a Vice-President, and on the death of King Edward in 1910 he was elected President of the Society, retaining this office till the following year, when H.R.H. the Duke of Connaught accepted it. Not only during his tenure of office as Chairman, but both before and after those years he took an active part in the Society's administration, and his attendance at the meetings of Council and of the Finance Committee was, despite the numerous calls upon his time, fairly regular until the serious, and ultimately fatal, illness, which began about two years ago.

Born in 1842, he was educated, like his father, at Charterhouse and at Trinity College, Cambridge.

His degree was respectable, for he took honours both in mathematics and in classics, being 38th Wrangler and in the third class of the Classical Tripos. His chief reputation at the University was as an athlete, for he certainly was one of the finest long-distance runners that the University has ever produced, remembering that his feats were always accomplished on grass, before the days of the cinder path, which indeed was not introduced at Fenner's until after he had gone down. To his contemporaries at Cambridge his rapid and great success at the Bar came as something of a surprise, for though he was always steady in his work, as in everything else he undertook, it was not yet recognised that his abilities were anything above the average.

His legal career has been fully dealt with in the numerous obituaries which have appeared in the daily papers, and not much need be said about it here. Suffice it to record that he was called to the Bar at Lincoln's Inn in 1868, and very rapidly obtained a large and lucrative practice. To some extent his success may have been due to his father's reputation, and to the fact that his father's friends fully appreciated the efforts he made as a young man to clear off certain liabilities incurred by the unsuccessful speculations of Mr. Thomas Webster, and were all the more ready to assist his son. His success, however, was certainly due, not to any adventitious help, but as he himself has said in the "Recollections" he published about a year ago, to his enormous capacity for work. He had a marvellous memory for details, and grudged no amount of pains in getting up his cases, or in mastering the *minutiæ* of anything he undertook. He would begin work long before most of his colleagues were out of bed, and continue at it steadily throughout the day. He never spared himself, and perhaps he was not much inclined to spare others not gifted with his iron constitution or his powers of strenuous endurance. Thus it happened that his capacity for painstaking work was soon recognised, and ten years after he was called he was certainly making a larger income than anyone of his standing.

When Sir Hardinge Giffard (Lord Halsbury) became Lord Chancellor, Mr. Webster was offered the post of Attorney-General, although he was not at the time in Parliament. He soon, however, obtained a seat for Launceston, and not long after he was elected for the Isle of Wight—a constituency which he represented for fifteen years. He naturally looked forward to the post of Lord Chancellor, but as Lord Halsbury's long continuance in office prevented the occurrence of a vacancy, he had, to his own bitter disappointment, as his friends knew, to accept in 1900 the office of Master of the Rolls. A few months after his appointment Lord Russell of Killowen died, and Lord Alverstone, as he was then created, became Lord Chief Justice. Although for the time he was not quite consoled even by this high office, he very soon realised how great that office was, and very shortly after his appointment he expressed himself in private, and evidently with perfect truth, as fully satisfied with his position.

Of his career as Lord Chief Justice, as of his career at the Bar, it is unnecessary to speak here. There seems little need at the present moment to draw comparisons between Lord Alverstone and other holders of his exalted office. Certainly, in his hands it lost nothing of its ancient dignity and reputation. In the discharge of its duties he acquitted himself to the full satisfaction of the Bar, and by his conduct in office added to the respect and regard in which he was held by the members of his profession. How great this respect was, was shown by the meeting held under the chairmanship of the well-known Parliamentary counsel, Mr. Samuel Pope, a strong Radical and a Home Ruler, to protest against the animadversions which had been made upon Sir Richard Webster in connection with the Parnell case, and to testify to the high consideration in which he was held by the Bar. In this light he was indeed ever regarded by his friends and acquaintances from the time that he was an undergraduate at Trinity down to the date of his death. A man of the finest character, he always bore a high reputation for straightforward and honourable behaviour, and he won the admiration of all those with whom he was brought into contact, either professionally or in the many other activities—religious, social, political, diplomatic, or even sporting—in which he was engaged.

Sir Thomas Jackson, Bt.—Sir Thomas Jackson, chairman and director, and late chief manager, of the Hong-Kong and Shanghai Bank, died suddenly at the bank in Gracechurch Street on the 21st inst.

He was born in 1841, and after being educated at Castle Knock, Ireland, he entered the service of the Bank of Ireland, Belfast. In 1864 he proceeded to India, to the Agra Bank, and two years later joined the Hong-Kong and Shanghai Bank. He was a member of the Legislative Council for Hong-Kong from 1884 to 1886, being the first elected member. He was knighted in 1899, and received a baronetcy in 1902.

Sir Thomas was also chairman of the Imperial Bank of Persia, and held appointments on the boards of several other banking and insurance companies, including the London County and Westminster Bank, the Union Discount Company of London, the Royal Exchange Assurance Corporation, and the Yorkshire Penny Bank.

He was elected a member of the Royal Society of Arts in 1900.

Sir William Wilson Mitchell, C.M.G.—The death is announced of Sir William Wilson Mitchell, which took place at Colombo, Ceylon, on the 15th inst. He had been a member of the Royal Society of Arts since 1900.

Sir William was born in Edinburgh in 1840. In 1863 he went out to Ceylon, where he devoted himself to mercantile pursuits and to tea-planting. He was the first to introduce the cotton industry

into Ceylon. In 1875 he was appointed a member of the Legislative Council; he rendered many services to the Government, and took a prominent part in the development of Ceylon. He was appointed one of its representatives at the Paris Exhibition of 1900, and in recognition of his services he was created a knight in that year. He had previously received the C.M.G. in 1895. He was senior partner of the firms, Messrs. Darley and Butler, London, and Messrs. Darley, Butler and Co., Colombo, and Consul for Mexico in that city.

GENERAL NOTES.

Serbian Orphanage.—Under the patronage of the Serbian Relief Fund a juvenile lecture on "The Home Life of interesting and beautiful Birds of other Lands" will be given by Mr. James Buckland, at the Whitehall Rooms, Hotel Metropole, Whitehall Place, S.W., on Tuesday, January 4th, 1916, at 3.30 p.m. Tickets, 5s. each, can be obtained at the usual agencies, or from Mrs. James Buckland, 29, St. Thomas's Mansions, Westminster Bridge, S.W. The proceeds will be given to the Children's Fund to build an orphanage in Serbia.

Gas from Peat.—According to a Friesland newspaper, the municipal gasworks at Akkrum in that province are extracting gas from peat mixed with coal. It is stated that if peat alone were used the retorts would become too hot, because of the steam created by the moisture always found in peat. Accordingly the retorts are filled with two parts in weight of coal to one of peat. The peat—as well as the coal—produces about 30 cubic metres of gas per 100 kilogrammes (220 lb.), and, according to a report by the United States Consul at Amsterdam, the gas produced from this mixture is declared to be of excellent quality. The peat is entirely consumed in the process, and therefore yields no by-products, as coal does in tar and coke; but the use of peat is a great saving of coal, which is important in Holland now, where all coal, and particularly gas coal, is scarce, and has to be imported from a distance at heavy cost. Peat, on the other hand, is plentiful, particularly in Friesland, and is dug in the vicinity of the gasworks.

Experiments in Cultivation of the Cork Tree in Sardinia.—A Sicilian journal, *I Nuovi Annali di Agricoltura Siciliana*, has lately published some interesting notes on the experiments made by Signor G. Cusmano, an inspector in the service of the Government penal settlements in the island of Sardinia, in the cultivation of the cork tree. The possibility of grafting slips of this tree on the evergreen oak was suggested by the botanical similarity of the two plants, and also by the latter's greater longevity. The experiments were made in 1913 at Sarcidano (province of Cagliari), and at Mamoni (province of Sassari). A large number of standards of the evergreen oak, about 3 ft. high and eight to ten years old, were grafted with shoots and with buds of the cork plant. These grafts were successful, and the operation repeated on a more extensive scale in the forest of evergreen oak of Castiados, in the province of Cagliari, was equally satisfactory. It was found that the best results were obtained from buds inserted on the stem and not on the branches of the tree. Besides yielding a more abundant and superior quality of bark, it is claimed that the life of a tree as a cork producer can be doubled, and the value of the forests of evergreen oak considerably enhanced, by adopting this method. It is estimated that during a life of 300 years such a tree would yield from 30 to 37 harvests of bark, as compared with the cork tree, which in 150 years can only be stripped 15 to 17 times. At the present time the timber of the extensive forests of the evergreen oak in Sardinia are only used for the production of charcoal. If transformed by this method into cork forests, each tree might yield 50 kilogrammes, to the value of 40 francs (about 1 cwt., worth 32s.), of excellent bark at each stripping.

Decrease in Number of Live Stock in France.—The result of a census of live stock existing in France on July 1st last has just been published by the Minister of Agriculture. From this it appears that on that date the total number of animals of various kinds was as follows:—

Horses	2,227,209	head
Mules	152,266	,,
Asses	332,244	,,
Cattle (bovine)	12,281,849	,,
Sheep	13,483,189	,,
Pigs	5,490,736	,,
Goats	469,487	,,
Total	34,436,980	

As compared with a census taken eighteen months ago, these figures show a falling-off of 31 per cent., or nearly one-third, in the number of horses. No census since 1840 has shown such low figures.

Agricultural Production of the United States, 1915.—According to the *Pacific Rural Press*, the last harvest seems to have been a record one. The following figures, given by that journal, show the totals of the different crops harvested this year:—

Description of Crop.	Quantity.
Winter wheat	685 million bushels
Spring wheat	206 ,, ,,
Maize	2,673 ,, ,,
Oats	1,141 ,, ,,
Barley	195 ,, ,,
Rye	43 ,, ,,
Buckwheat	17 ,, ,,
Potatoes	406 ,, ,,
Tobacco	1,035 million lbs.
Hemp	16 ,, bushels
Hay	70 million tons
Apples	253 ,, bushels
Peaches	54 ,, ,,

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m. :—

January 19. — Lawrence Chubb, "The Common Lands of London: the Story of their Preservation." Lord Farrer will preside.

January 26.—J. Arthur Hutton, Chairman of the British Cotton Growing Association, "The Effect of the War on Cotton Growing in the British Empire."

February 2.—S. Charles Phillips, M.S.C.I., "Paper Supplies as affected by the War."

February 9.—Professor J. A. Fleming, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

February 16.—The Hon. Lady Parsons, "Women's Work during and after the War."

February 23.—Miss H. B. Hanson, M.D., B.S., D.P.H., "Experiences in Serbia."

Indian Section.

January 13. — Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., late Survey of India, "The Romance of the Indian Ordnance Survey." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

February 17.—C. A. Kincaid, C.V.O., Indian Civil Service (author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.), "The Saints of Pandharpur." Lieut.-Colonel Sir David W. K. Barr, K.C.S.I., will preside.

March 16.—Professor Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

Dates to be hereafter announced :—

R. W. Seton-Watson, D.Litt., "The Balkan Problem."

Charles R. Darling, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

Rev. P. H. Ditchfield, "The England of Shakespeare."

W. A. Craigie, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

Victor Horta, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

Charles Delchevalerie, "Belgian Literature."

Professor T. G. Masaryk, "The Slavonic Peoples."

G. P. Baker, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

Sir Daniel Morris, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

James MacKenna, M.A., I.C.S. (Deputy Commissioner, Myaungmyn, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

Indian Section.

Thursday afternoons at 4.30 p.m. :—

April 6, May 18.

Colonial Section.

Tuesday afternoons, at 4.30 p.m. :—

February 1, March 7, May 2.

Cantor Lectures.

Monday afternoons at 4.30 p.m. :—

J. Erskine-Murray, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

Fothergill Lectures.

Monday afternoons, at 4.30 p.m. :—

Rev. Dr. Herbert West, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "Flemish Architecture." Three Lectures.

February 7, 14, 21.

Edward A. Reeves, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

Juvenile Lectures.

These Lectures will be given on Wednesday afternoons, January 5 and 12, at 3 p.m. The first lecture will be given by Professor John Millar Thomson, LL.D., F.R.S., on "Crystallisation," and the second by Mr. James Swinburne, F.R.S., on "Science of some Toys."

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FRIDAY, DECEMBER 31, 1915.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 5th, 3 p.m. (Juvenile Lecture.) PROFESSOR JOHN M. THOMSON, LL.D., F.R.S., "Crystallisation."

The lecture will be fully illustrated with numerous experiments.

Special tickets are required for these lectures, and no person can be admitted without a ticket. A few tickets are still left, and these will be issued to Fellows who apply for them at once.

Further particulars of the Society's meetings will be found at the end of this number.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

COVERS FOR JOURNALS.

For the convenience of Fellows wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s.* 6*d.* each, on application to the Secretary.

THE ORIGIN OF ENGLISH MEASURES OF LENGTH.

By COLONEL SIR CHARLES M. WATSON, K.C.M.G., C.B., R.E.

Although there is considerable variety in the measures of length used by the different nations of the world, there can be no doubt that they are, for the most part, derived from a common origin, and that their ancestors, if the expression may be used, existed in times so remote that the date of their invention has been completely lost. But the study of what the original measures were is a matter of considerable historical importance, and the question can be investigated by an examination of the changes made in the course of generations by the people who have adopted them—changes, in some cases, apparently due to accident rather than design.

For the sake of clearness, it is convenient to divide the measures of length into four categ ories which are, to a certain extent, independent of one another, and may be defined as follows:—

(1) The shorter measures of length, used for building and manufacturing purposes, of which the more important in ancient times were the cubit, the palm, and the digit, or finger breadth, and the English representatives are the yard, the foot, and the inch. (2) The shorter measures of distance, such as the foot, the yard, and the pace. (3) The longer measures of distance, including the stadium, the mile, the parasang, the schoenos, the league, the hour's march, and the day's march. (4) Measures of length used in connection with the calculation of land areas, of which the English representatives are the perch, the chain, and the furlong.

As regards the first of these classes of measures, it is generally accepted that they were, from the earliest times, based on the proportions of the human body, so that every man had his own scale to which he could work. As, however, men are not all of the same size, there is considerable variety in the length of the different units, but, with some exceptions, they may be included within the following limits:—

The digit (or finger breadth)	from 0·72 to 0·75	English in.
The palm,	,, 2·88 to 3·00	,, inches.
The cubit,	,, 17·28 to 18·00	,, ,,
The fathom,	,, 5·50 to 6·00	English ft.

The palm is the width across the open hand at the base of the fingers; the cubit is the length of the arm from the elbow to the end of the middle finger; and the fathom the length of the outstretched arms. There is no fixed relationship between these units.

There is no record as to when an attempt was first made to combine the measures in a standard scale, but it was probably at an early period, as it must have been found inconvenient for workers on the same building, for example, to use different lengths of palms and cubits, and, when a standard was fixed, it may have been some such scale as the following:—

1 digit =	0·7375	English inch.
4 digits = 1 palm =	2·95	,, inches.
6 palms = 1 cubit =	17·70	,, ,,

The cubit of this scale may be called the "cubit of a man," to distinguish it from other cubits, which will be described hereafter.

In process of time it was found desirable to have a smaller unit than the digit, and this was made by taking it as equal to six grains of barley placed side by side. In the English scale, barleycorns were also used as the smallest measure of length, but in this case they were placed end to end, three barleycorns so placed being taken as equal to one inch.

There is no evidence that the foot was included originally among the units of the hand worker given above, and it may, perhaps, more properly be regarded as belonging to the second class of measures, derived from the distance covered by a man walking, and as a subdivision of the important unit, the pace. The pace is of two kinds, the first being the single pace, or distance covered by the step of one foot, and the second, the double pace, the distance covered by both feet one after the other.

In the case of the Roman double pace, a very important measure, the pace was taken as equal to five feet, but this was an artificial connection, as there is no fixed proportion between the length of a man's foot and the length of his pace.

There is nothing to show when the foot was added to the units of the mechanic's scale, but when this was done it was assumed to be equal to four palms, or two-thirds of a cubit.

The third class of measures of length is the most important, and the history of these is of particular interest, as they appear to have started in a state of perfection, and to have been first used by a people who possessed a high degree of astronomical and mathematical knowledge, who were acquainted with the form of the earth, and were able to carry out accurate geodetical measurements. It is also remarkable that the changes made as regards these measures in the course of time have been changes for the worse, in consequence, apparently, of the origin of the measures having been forgotten. There can be no doubt that they are based on the angular division of the circle, and on the application of this division to terrestrial measurements.

The unit of angular measurement is the angle of an equilateral triangle, and this angle was divided by the ancient geometricians, for purposes of calculation, into 60°, the best number possible, as $60 = 3 \times 4 \times 5$. Following the same principle, each degree was divided into 60 minutes, and each minute into 60 seconds. As the circle contains six times the angle of an equilateral triangle the circle was divided into 360°. This division of the circle, although so ancient that its origin is unknown, has never been improved upon, and is still in use by all nations. An attempt on the part of certain French mathematicians to substitute a division of the circle into 400°, on account of the supposed advantages of the decimal system, has proved a failure.

The manner in which the division of the circle into 360° was used by the ancients to determine the unit for terrestrial measures of distance was as follows. If a circle be described cutting the equator of the earth at right angles, and passing through the north and south poles, its circumference in angular measurement is equal to $360° \times 60' = 21{,}600'$, and the length of 1 minute, measured on the surface of the globe, was taken as the unit, which is called a geographical mile at the present time. If the earth was a perfect sphere, every geographical mile would be of the same length, but, as the polar diameter is less than the equatorial diameter in the proportion of 7,900 to 7,926, the length of the geographical mile, measured on the meridian, is not the same in all latitudes, but increases in length from 6,046 English feet at the equator to 6,108 English feet at the poles. Whether the ancient astronomers were acquainted with this irregularity in the figure of the earth it is not possible to say, but it is certain that the value at which they fixed it must have been close to the actual mean value as determined by modern astronomers, which may be taken as about 6,075 English feet. The Greek stadion (the same as the Roman stadium), which was one tenth of the geographical mile, was 600 Greek feet in length, and the Greek foot was about 12·15 of our present English inches.

The next step taken appears to have been with the view of assimilating the subdivisions of the geographical mile with the cubit, and it was not easy to do this, as the cubit of a man has no necessary connection with a geographical mile. The difficulty appears to have been solved by the invention of two new cubits, of which the smaller was very nearly equal to the cubit of a man, and was contained 4,000 times in the geographical mile. This, for the sake of distinction, may be called the geographical cubit. The second cubit, afterwards known as the Babylonian Royal cubit, was longer, and was contained 3,600 times in the geographical mile. According to Herodotus this second cubit was three digits longer than the other cubit. On these two cubits there appear to have been based two different divisions of the geographical mile, one in accordance with a decimal, and the other with a sexagesimal system of calculation, but there is, so far as I know, no ancient record of these scales, and the following attempt to compose them is founded on inferences, drawn from the Babylonian, Greek and Roman measures, all of which, there can be little doubt, came from the same origin.

The first, based on the geographical cubit, which was rather longer than the average cubit of a man, is as follows:—

	1 digit	= 0·729	English inch.
25 digits	= 1 geographical cubit	= 18·225	„ inches.
100 „	= 1 fathom	= 6·075	English feet.
100 fathoms	= 1 stadion	= 607·5	„ „
10 stadia	= 1 geographical mile	= 6075	„ „

The second, or sexagesimal scale, based on the Babylonian Royal cubit, appears to have been as follows:—

	1 digit	= 0·723	English inch.
28 digits	=1 Royal cubit	= 20·25	„ inches.
60 cubits	=1 plethron	=101·25	English feet.
60 plethra	=1 geographical mile	= 6075	„ „

Some writers are of opinion that the Babylonian Royal cubit was composed of 30 instead of 28 digits, but this appears to be improbable, because it would make the digit too small, and, if Herodotus is correct, it would make the cubit in the decimal scale consist of 27 digits, an inconvenient number. Nor is there any evidence to prove that a cubit was ever divided into 27 digits, while Professor Petrie has shown, in "Inductive Metrology," that the division of the cubit into 25 digits, and of the fathom into 100 digits, is very probable. There was another Babylonian measure of length called the gar, used for land measurements, which appears to have been composed of 12 Royal cubits. It was the ancestor of the English land measure, the perch, which is 11 English cubits in length.

The ancient Egyptian measures of length, although evidently derived from the same origin as the Babylonian, differ from these in some respects. The most important smaller unit was a cubit usually known as the Egyptian Royal cubit, which was divided into seven palms, each palm of four digits. The approximate length of the Egyptian Royal cubit is well known, as a number of cubit scales have been found which give a mean length of 20·65 English inches, and an examination of the monuments of Egypt shows that this cubit was used for building purposes from ancient times.

Professor Petrie, in "Inductive Metrology," has given a large number of samples of the Egyptian cubit derived from the measurements of buildings, which vary from 20·42 to 20·84 English inches, and yield a mean value of 20·64 English inches, or almost exactly the same as the mean length of the cubit scales.

As is generally the case with regard to measures of length in all countries, the Egyptian cubit appears to have grown longer in course of time, and there is a good instance of this shown by a comparison of the three nilometers on the island of Philæ, above Assuan, of which the first gives a mean value for the cubit of 20·47 English inches, the second of 20·81, and the third of 21·05 English inches.

The best results given by Petrie are based on his measurements of the Great Pyramid of Gizeh, the great chamber of which, having a length of 20 cubits and a width of 10 cubits, yields a cubit of 20·627 English inches, while the height of 78 palms gives a cubit of 20·65 English inches. The length of the side of the base of this pyramid is of particular interest, as it appears to have been designed as one-eighth of a geographical mile. This length is not easy to measure, as the lower part of the pyramid is covered with sand and rubbish, and the stones which cased it have been removed. Petrie, after very careful measurement, arrived at the conclusion that it was 755·7 English feet. There are reasons for thinking it may have been a little more than this, but less than 760 feet. The length of a geographical mile at the latitude of the pyramid is 6,060 feet, and one-eighth of this is 757·5 feet, or so nearly equal to the length of the side of the base that it is difficult to believe that the architect had not this in view when he designed the pyramid. The side of the base was therefore equal to 500 geographical cubits, and very nearly equal to 440 Egyptian Royal cubits—a remarkable coincidence, if it is only a coincidence. It is interesting to note that there are 440 English cubits in the English furlong, but whether this has any connection with the measure of the pyramid there is no evidence to show.

There was a good reason for making the side of the base 440 cubits, as the height is equal to the radius of a circle, of which the perimeter of the base is the circumference, so that the height was 40×7 cubits, and the length of the side 40×11 cubits. It would be interesting to know how the ancient Egyptian geometrician arrived at so close an approximation to the value of π as $\frac{22}{7}$.

It is matter of controversy from whence the Greeks derived their measures of length, whether from Egypt or Babylonia; but the latter appears more probable, as their principal measure of distance, the stadion, was equal to one-tenth of a geographical mile of 6,075 English feet, and this was divided into 6 plethra, each of 100 Greek feet. The Greek scale appears to have been as follows:—

	1 Greek foot	= 12·15	English inches.
$1\frac{1}{2}$ Greek ft.	=1 cubit	= 18·225	„ „
10 „ „	=1 reed	= 10·125	English feet.
10 reeds	=1 plethron	=101·25	„ „
6 plethra	=1 stadion	=607·50	„ „
10 stadia	=1 geographical mile	= 6,075	„ „

There was another foot used in Greece, of which Petrie gives a number of instances, derived from old buildings, varying from 11·43 to 11·74, with a mean value of 11·60 English inches. This would appear to be a foot of 16 digits, used for building and manufactures, but not connected with measures of distance.

The Roman system of measures was based on the Greek, but while adopting the stadion—called by them stadium—as the fundamental measure of distance, they used the shorter Greek foot, and introduced another measure, the double pace. They also made the land mile to consist of 8 instead of 10 stadia, while retaining the geographical mile of 10 stadia for use at sea. As they had an affection for a duodecimal system of calculation, they also divided the foot into 12 inches, in addition to the old division into 16 digits. The Roman scale, which showed considerable ingenuity in assimilating a number of different measures

which had no real relationship to one another, appears to have been as follows:—

		1 digit	= 0·729	English inch.
		1 inch	= 0·972	,, ,,
4 digits or 3 in.	=	1 palm	= 2·916	,, inches.
4 palms	=	1 foot	= 11·664	,, ,,
6 ,,	=	1 cubit	= 17·496	,, ,,
5 feet	=	1 pace	= 4·86	English feet.
125 paces	=	1 stadion	= 607·5	,, ,,
8 stadia	=	1 land mile	= 4,860	,, ,,
10 ,,	=	1 geographical, or sea mile	= 6,075	,, ,,

The land mile was probably made up of 8 stadia in order to have it exactly 1,000 paces in length, or it may have been considered that eight was a more convenient number for dividing than ten; but it was necessary to retain the mile of 10 stadia for navigation.

The above remarks deal with the measures of distance used by the principal nations of antiquity up to and including the geographical mile, upon which they seem to have been based, but in addition to these there are certain longer measures of distance which must be referred to, such as the parasang, the schoenos, and the league. The fundamental idea of these measures was that they represented the distance which could be marched in a given time, such as one hour, and as the rate of marching naturally varied with the nature of the country, it was not easy to have a fixed length, and when there was made a theoretical unit it did not always agree with the actual distance.

There is a good example of this in the "Anabasis" of Xenophon, in which the writer recorded the distance travelled by the Greek force, day by day, on their way across Asia Minor from Ephesus to the Euphrates, and, after the battle of Cunaxa, from the Euphrates to the Black Sea. Xenophon gives the distance from Ephesus to the battlefield as 535 parasangs, or 16,050 stadia, thus making the parasang equal to 30 stadia, or 3 geographical miles. But Colonel Chesney has pointed out that the actual parasang, or hour's march, was less than this, and that it averaged 26 stadia from Sardis to Thapsacus, and about 20 stadia from Thapsacus to the battlefield of Cunaxa. A fair average hour's march for an army would be 25 stadia or 24 stadia, equal to 3 Roman miles, and a day's march of eight hours to 20 geographical or 24 Roman miles. In the Antonine Itineraries the distance between important stations is, in a number of cases, given as 24 and 25 Roman miles, which looks as if the stations were fixed at distances apart suitable for a day's march.

In Egypt the measure of distance corresponding to the parasang was the "ater," called "schoenos" by the Greeks, and stated by different writers to have been equal to 30, 32, 40, and 60 stadia in various parts of Egypt. It is evident that it was based on the geographical mile as a rule, while 32 stadia is equal to four Roman miles. There is some doubt whether the Egyptians had a fixed length for the schoenos, and a good deal has been written with regard to it, notably a paper entitled "Der Schoinos bei den Aegyptern, Griechen und Römern," by Wilhelm Schwarz, published at Berlin, 1894.

Another longer measure of distance, which was largely used in the western parts of Europe under the Roman Empire was the Gallic league, equal to 12 stadia or one and a half Roman miles. In the Antonine Itineraries the distances in Gaul are in some cases given in leagues, and in others in both leagues and Roman miles, while, in the "Bordeaux Pilgrim," a work dating from the early part of the fourth century, the distances in the west of France are given in leagues, and afterwards in Roman miles.

An important application of measures of distance from the earliest times was for the calculation of areas of land, but there is considerable doubt as to what was the original unit, and whether this was a square, or in the form of a rectangle one stadium in length and one-tenth of a stadium in width. In the latter case there would have been ten measures in a square stadium, and 1,000 measures in a square geographical mile, and such a measure would seem quite in accord with the ancient system of measures of distance. Its area would have been 40 × 400 geographical cubits (36 × 360 Babylonian Royal cubits), or 0·847 English statute acre. There is a very widely distributed type of land measures based on a rectangle of this form, of which the English acre is an instance, as it measures 44 × 440 English cubits.

The Egyptian unit of land area appears to have been the "set," called "arura" by the Greeks, which was a square having a side of 100 Egyptian Royal cubits. A cubit of land was the $\frac{1}{100}$ part of this, and was the area of a rectangle 1 × 100 cubits.

In the Greek system the unit of area was the square of a plethron or 100 Greek feet, equal to 0·235 English acre, of which there were 36 in a square stadion and 3,600 in a square geographical mile.

The Roman unit of land area, called the "jugerum," was a rectangle, 120 × 240 Roman ft., or 0·624 English acre, which was subdivided duodecimally, the uncia of land being the twelfth part of a jugerum, or the area of a rectangle measuring 10 × 240 Roman feet. The relative proportions of these different units of land area were as given on page 129.

It will be seen from the above descriptions that from the earliest times the shorter measures of length were based on the proportions of the human body, and the longer on the geographical mile, and that at some remote period an attempt was made to combine them into a continuous scale, from the digit to the geographical mile. When the digit was made the point of departure the decimal system of calculation appears to have been preferred, and when the scale was worked downwards from the mile the sexagesimal system was the most convenient, while in the Roman scale the

Area of Unit.	Number contained in Geographical Miles.	Area in English Statute Acres.
36 × 360 Babylonian Royal cubits	1,000	0·847
100 × 100 Greek feet	3,600	0·235
120 × 240 Roman feet	1,356	0·624
100 × 100 Egyptian Royal cubits	1,240	0·683
Geographical square mile	1	847·238
English square mile	1·324	640

duodecimal system was introduced. But it is to be regretted that the more ancient system was not retained, by which the geographical mile was the unit, and was divided into 10 stadia, each of 400 cubits, or 600 feet, as it is doubtful whether the changes made by succeeding generations can be regarded as improvements.

The modern measures of the civilised world are, with few exceptions, based on the ancient units, of which they may be regarded as the direct descendants. Of these exceptions the most important are the measures of the metric system, which were designed with the object of breaking away from the records of the past by the adoption of a new geographical mile, equal to $\frac{54}{100}$ of the true geographical mile.

The English measures of length are a good example of the modern representatives of the old units, and are worthy of study from this point of view. How the measures originally came to England it is not easy to say, but there can be no doubt that they were in use before the Roman invasion, having possibly been introduced by Phœnician traders, and were afterwards modified by the Romans, the Saxons, the Scandinavians, and the Normans, each of whom had measures, based on the old units, but altered in course of time. It was not until the thirteenth century that they were moulded by law into one uniform system.

The English scale, as authorised by statute, may be summarised as follows:—

	1 inch.
12 inches	= 1 foot.
3 feet	= 1 yard.
5½ yards	= 1 rod, pole, or perch.
4 perches	= 1 chain.
10 chains	= 1 furlong.
8 furlongs	= 1 English statute mile.

Of these units the inch is derived from the Roman system, being one-twelfth of the foot, but the foot, on the other hand, is equal approximately to the Greek foot, while the yard, which is simply a double cubit, comes from the Babylonian system, being approximately a double geographical cubit. The perch is the English representative of the Babylonian gar, and the furlong occupies a similar place to the stadium, while the mile is composed of eight stadia, apparently in imitation of the division of the Roman mile. For use at sea, however, the geographical mile, divided into ten stadia, or, as we call them, cable lengths, has been retained, as no other mile can be used for purposes of navigation.

In order fully to understand the connection between the English measures and the ancient measures of length, it is necessary to write the scale in a somewhat different manner, and to introduce some other units which are no longer used. The revised scale is as follows:—

	1 barleycorn.
3 barleycorns	= 1 inch.
3 inches	= 1 palm.
4 palms	= 1 foot.
6 ,,	= 1 cubit.
12 ,,	= 1 double cubit or yard.
11 cubits	= 1 perch.
405 ,,	= 1 cable's length.
4 perches	= 1 acre's breadth or chain.
10 chains	= 1 acre's length or furlong.
8 furlongs	= 1 English mile.
10 cables	= 1 geographical, or sea mile.

The English inch is equal in length to 3 barleycorns set end to end, or to the width of 8 barleycorns, set side by side. The barleycorn, as a measure, is forgotten, but the inch on carpenters' rulers is still divided into eight parts, while, on a shoemaker's tape, the sizes of boots and shoes increase by a barleycorn, or ⅓ inch, for every size. For example: size No. 8 of a man's boot measures 11 inches; size No. 9, 11⅓ inches; size No. 10, 11⅔ inches, and so on. One would have thought that the sizes would increase by one quarter of an inch at a time, but the barleycorn has held its place to the present day.

The palm, which was originally composed of 4 digits or finger breadths, and, since the time of the Romans, of 3 inches or thumb breadths, is no longer used in England, and its place has to a certain extent been taken by a measure called the hand, composed of 4 inches and employed in measuring the height of horses. The change may have been due to the fact that the number 4 was more convenient for division than 3, and that when the digit gave way to the inch the palm of 4 digits was replaced by the hand of 4 inches.

Prior to the thirteenth century, the length of the foot in England was uncertain, and there appear to have been several measures in use, varying from the Roman foot of 11·66 English inches to the Belgic foot of 13·12 English inches; but, by the Ordinance known as the Statute for Measuring Land, enacted in the reign of King Henry III., the relations of the inch, the foot, and the cubit to one another were definitely fixed, and have never since been altered. The cubit of this Statute is the double cubit, afterwards called the yard. A translation of the Latin words of the Statute, describing the different measures, is as follows:—

"It is ordained that 3 grains of barley, dry and round, make an inch; 12 inches make a foot; 3 feet make a cubit; 5½ cubits make a perch; 40 perches in length and 4 perches in breadth make an acre.

"And it is to be remembered that the iron cubit of our Lord the King contains 3 feet and no more; and the foot must contain 12 inches, measured by the correct measure of this kind of cubit; that is to say, one thirty-sixth part of the said cubit makes one inch, neither more nor less. And 5½ cubits, or 16½ feet, make one perch, in accordance with the above-described iron cubit of our Lord the King."

It is interesting that, in this Statute, the double cubit, thus accurately described, should have been called the cubit of the King, just as the longer cubits of Babylon and of Egypt were called Royal cubits to distinguish them from the shorter cubits of those countries. In the Latin original of the Ordinance the word used is "ulna," the usual word for cubit. The word "yard," to signify the English double cubit, occurs for the first time in the laws of England in a Statute of 1483, which is written in French.

The perch, equal to 11 single or 5½ double cubits, is a very ancient measure, but I cannot find at what period it was first used in England. It was employed principally in connection with the measurement of land, and I have already pointed out its likeness to the Babylonian measure the gar, which was composed of 12 Babylonian cubits.

The two measures, the acre's breadth, afterwards called the chain, and the acre's length or furlong, have also been used from a very early period. The former is equal to 44 single cubits, 22 yards, or 66 English feet, while the latter is exactly ten times this, 440 cubits, 220 yards, or 660 feet. The furlong is the modern representative in our system of the ancient stadium, which had a length of 600 Greek feet, or 607·5 English feet, but the reason for its being longer than the stadium has, so far as I know, not been satisfactorily explained. But the change may have been due to the fact that other measures of distance were in use in England prior to the present statute mile, which varied in different parts of the country, and the mean of these was approximately equal to the Gallic league of 12 stadia or 7,290 English feet. One-eleventh of this, 663 English feet, is approximately equal to the English furlong, and eight of these measures, following the Roman system, were combined to form the English statute mile.

But whether this is the origin or not, there appears little doubt that the mile, furlong, and chain, or acre's breadth, were in use in England in Anglo-Saxon times, as there is a law of King Athelstane, who reigned A.D. 925-940, in which it is enacted:—

"Thus far shall be the King's grith from his burgh gate where he is dwelling, on its four sides; that is three miles, and three furlongs, and three acre's breadths, and nine feet, and nine palms, and nine barleycorns."

The length of the measure called the King's grith, or King's peace, was the distance from his house within which peace was to be maintained, and it is evident that in this law an attempt was made to express the distance in terms of ordinary measures. Converting these terms into feet we have:—

3 miles	= 3 ×	5,280 feet	=	15,840 feet.
3 furlongs	= 3 ×	660 „	=	1,980 „
3 acre's breadths	= 3 ×	66 „	=	198 „
9 feet	=	9 „	=	9 „
9 palms	=	2¼ „	=	2¼ „
9 barleycorns	=	¼ foot	=	¼ foot.
		Total	=	18,029½ feet.

18,029½ = 601 × 30 very nearly, so that it would appear that the length of the King's grith was 30 stadia, the same measure as that known in the East as the parasang, and in Egypt as the schoenos. It is remarkable that this measure should thus appear to have found its way to England, and there be regarded as a Royal measure.

There was another measure of distance used in England, known as the leuga, composed of 12 furlongs, which corresponded to the Gallic league of 12 stadia already described. In the Chronicles of Battle Abbey, which extend over the period A.D. 1066-1176, in the account of the lands belonging to the abbey, the following statement occurs: "The English leuga contains 12 roods (furlongs), and 40 perches make one rood; the perch is 16 feet in length; the acre is 40 perches in length and 4 in breadth; but if it is 20 perches in length, it shall be 8 in breadth." The acre's length, here called rood, and the acre's breadth appear to have been the same as in the time of King Athelstane, and the foot is the Saxon foot, equal to 12·375 of our present inches. The measurement of the acre, 4×40 perches, is the same as that given in the Statute for Measuring Land enacted in the reign of King Henry III., which has already been referred to.

The terms acre's length and rood are no longer used, and this measure is now known as the furlong, while the acre's breadth has been called the chain since the beginning of the seventeenth century, when it was divided into 100 links instead of 66 feet. The chain, which was the invention

of Professor Gunter, has proved very convenient for the measurement of land acres, and is now always used.

Since the introduction of the chain, the perch or rod has been less employed in connection with land measures, but is still used by builders for the measurement of brickwork. The common English stock brick is half a cubit in length, one quarter of a cubit in width, and one-sixth of a cubit in thickness, or rather less than these dimensions, to allow for the thickness of the mortar joints, while a rod of brickwork, which is the unit for builders' work, is a mass of brickwork, one rod or 22 bricks in length, one rod or 66 bricks in height, and three bricks in thickness. The perch or rod of brickwork contains 4,356 bricks.

The English sea mile is exactly the same as the geographical mile of the Babylonian system, and its tenth part, the cable length, is identical with the stadium. In these measures there has been no change, and the only difference is that the cable length is 405 English cubits, whereas the stadium was 400 original cubits. This is due to the fact that the English cubit is a little shorter than the latter in consequence of the English foot, as fixed by law, being rather less than $\frac{1}{6000}$ part of the geographical mile.

It will be seen from the above *résumé* that our English measures of length are no haphazard modern invention, as some people imagine, but have come down to us from prehistoric times. They have proved most convenient for the different uses to which they are applied, and it is to be hoped that they will never be abandoned in favour of the metric measures, notwithstanding the pertinacity with which the advocates of the latter press their views on the public. Such a change would do England no good, but would considerably assist foreign manufacturers; and there can be little doubt that the agitation in favour of the metric system has been pushed by German agents in this country, as they are fully aware that it would be for the advantage of German trade and assist in that capture of the world's commerce for which Germany has been working for many years. Possibly one effect of the present war may be to put an end to the attempt to abolish our English measures in order to compel Englishmen, against their will, to adopt those of the metric system.

DROUGHT-RESISTING GRASS SEEDS IN SOUTH AFRICA.

In the course of an article entitled "Notes on some Effects of Extreme Drought in Waterberg, South Africa," which appeared in the Agricultural Journal of the Union of South Africa, and is reprinted in the annual report of the Smithsonian Institution, Mr. Eugène N. Marais gives an interesting account of the way in which the seeds of certain coarse, rank, and "sour" grasses have adapted themselves to resist the droughts which are becoming more frequent and of greater intensity in the Waterberg district.

The life history of these seeds, he says, is one of those fairy tales of botany that might be of interest even to the busy man who has no time to notice. With a body shaped like a torpedo, and a long tapering tail, they have attained in perfection the tadpole shape, which Nature finds of such advantage that she has evolved it a thousandfold in the highest and lowest forms of life—indeed, it is probable that from such a shape have all organic forms originated. Under low magnification it will be seen that both body and tail are thickly studded with sharp, stiff bristles growing backward. The point of the torpedo is an intensely hard, horny spike, sharp as the point of a needle, with a coronal of harpoon points at its base. The seed is thus able to cling to the coats of animals, besides being easily moved off by the wind. But these qualities are of more immediate value in another direction. It is above all things a penetrating machine—how efficient one can judge from the fact that it is often found in the internal tissues of animals, having gone through coat, muscle, and flesh. It often penetrates human flesh, and is then always a source of serious danger. Every movement, however slight, causes the embedded seed to penetrate deeper, and frequently a serious operation only can remove it.

But it was not for this purpose only that its penetrative qualities were evolved. It is a common thing in good rain years to come across a mass of these seeds drifted together by the wind. It is then that one has an opportunity of seeing a wonder of plant life quite startling in the apparent intelligence disclosed. The seeds as they lie are huddled and orderless, like casually thrown spillikins. If one sprinkle a little water on the mass a tremor as of awakening life is almost immediately seen to pass through them. Movements in all directions follow—spasmodic jerks, twistings, and turnings so animal-like as almost to leave one in doubt whether they veritably are seeds and not insects. And this doubt intensifies as the process continues and the purpose becomes more apparent. One sees that by these movements the seeds are disentangling themselves, and when this is effected each one becomes engaged in independent movements. At first it all seems erratic and casual, and it is only after careful watching that it dawns upon one that all these movements are quite ordered, and have a definite purpose. The first spring-like twistings lift the seedhead clear off the ground and free it from obstructing fellows. A bend of the tail, on which it then rests, turns the torpedo-head point earthwards. It is gradually lowered until the needle-point, with its harpoon bristles, is thrust into the damp soil with a steady and continuous pressure from the tail. This movement is continued until the entire seed is embedded, the whole operation lasting fifteen minutes. But its chief protection against drought, and the accompanying ineffective and, in fact, fatal night-showers lies herein, that if the soil be only slightly damped the seed penetrates

beyond the line of moisture, and remains thus without germinating, ready planted, waiting for enough rain to ensure the safety of the future seedling. This penetration is proportionate to the length of tail, and it will be found at the end of a season of severe drought that the species with the longest-tailed seeds have started more seedlings than the relatively short-tailed. The hard shells of these seeds also require a definite and large amount of moisture to soften.

MANUFACTURE OF PAPER FROM SUGAR-CANE BAGASSE.

The manufacture of paper from sugar-cane bagasse has been repeatedly attempted in Cuba, and the final results can be estimated from the following particulars extracted from a recent report by the Canadian Acting Trade Commissioner at Havana.

In conjunction with the making of sugar from cane at Preston, another important industry is being conducted successfully in the manufacturing of wrapping paper from the by-product of sugar-cane bagasse or pulp. The mill has now been in operation for a period of ten months, and in the earlier stages was only operated as an experiment. The work was started in connection with, and under the direction of, the Wisconsin University Laboratories, where the original tests and experimental work were carried on, and the plant at Preston is now in charge of the graduates of this institution. A staff of twenty-five men is now employed in the mill, and four tons of paper is the daily output. The facilities and machinery at present provide only for the manufacture of several grades and weights of wrapping paper. Arrangements are now under way, and the required machinery will be added, for the manufacture of all grades of paper. The pulp runs about two tons to one of paper.

The buildings are of a sheet-metal construction, and are fireproof. In the main building three elevations of the floors are used in transferring the pulp to paper. The process of manufacture is as follows:—

The bagasse is carried from the sugar-mill in cars to the paper-mill, and then conveyed to the top floor of the paper factory. From there it is shovelled to the floor below into "digester" tanks, where it is digested or boiled by live steam. The only difference noticeable to a layman between the manufacture of bagasse paper and that of wood-pulp paper is the process of digestion or boiling in order to soften the stock to the desired point at which it can be beaten, and this digesting takes the place of grinding up the wood. The bagasse is transferred from the digesters to the beaters and beaten into pulp, when chloride of lime is added to the pulp in the beaters (of which there are four), and when beaten to a sufficient consistency is dropped in pipes to retaining tanks on the floor below. From the retaining tanks the pulp is carried to the paper-mill or machine, where a quantity of water is added to it to get the thin solution. This thin solution is run over a wire screen, and all the water is extracted by means of suction. The paper is then dried on the usual steam drums of a paper-mill.

Three weights of wrapping paper are manufactured, of which the highest is 80 lb. In the case of making paper from cane bagasse, the necessary grinding is done at the mill in the production of sugar, which eliminates this process of manufacture at the paper-mill. The paper obtained from cane pulp is equal to, if not slightly better than, the paper manufactured from imported kraft stock, and it can be produced and marketed at a price considerably lower than that quoted for kraft paper. Samples of the paper show various colours, and a considerable degree of strength. The output is sold in Cuba for local consumption.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Government Requisitions.—The commandeering by the Government of about half the production of Dundee jute goods during the next three months is a repetition of an experiment previously made in the same quarter. It can be assumed, therefore, that, from the Government point of view, the issue of the experiment has been successful. The requisitioning of machinery operates, of course, in favour of promptness in delivery, and the fixing of prices as between spinners and manufacturers, and again between manufacturers and the purchasing department, at least puts limits to the hoist of prices. The policy would appear to have secured supplies at handsomely lower rates than were, or are, asked of private traders, and that aspect of the matter has a wider interest. Men concerned in other textile markets have been asking whether it might not have been better had the Government taken the same course in regard of other commodities that have been forced up in price by the demand for military clothing. That it would have been better for the Government on the score of economy is freely assumed. Some traders, at all events, are disposed to think it would have been better also for themselves, and would have moderated prices in the regular market. Circumstances alter cases, but so far as Dundee evidence goes, the residue remaining after Government requirements had been filled would still have been susceptible of increase in price.

Cotton Trade Losses.—The extra cost of bringing raw cotton from America to Lancashire is estimated roundly at one penny per lb.: a formidable charge upon a 7½*d.* article. Fuel for the mills costs 40 per cent. more, leather 50 per cent., oil and repairs 20 per cent., cartage

10 per cent., and labour 5 per cent. more than they did in time of peace. These charges, uncompensated by gains in efficiency, or in the purchasing power of the principal markets, and only imperfectly balanced by corresponding increases in the costs of competitive work in some neutral countries, are of a mischievousness difficult to exaggerate. They go to explain more than loss of profit, and would render worse records than Mr. Kidger's intelligible. In his annual financial statement of the progress of one hundred Oldham cotton-spinning mills, he shows that on a capital of slightly over £3,500,000 the aggregate loss was £15,000. Forty-two companies made profits, and they were either ring-spinning mills or producers of coarse counts. It is significant of how war turns everything about that the mills to do best should be those equipped with spindles of a type used more abroad than at home, and mills producing the thick yarns that have been left so generally to the foreign spinner. It happens that these yarns have been needed for the purposes of war, and the profits have gone to those in a position to take up the business. With the aid of their reserves the hundred companies have distributed an average dividend of 5 per cent., and the payment of it is one sign of a hope of better days in store for what is in effect a reduced industry. The absorption of men into the Army, by curtailing production, achieves much the same result as the organised short-time working which is the normal remedy for low margins.

British Dyes.—Impressively large extensions have been made to the nucleus works of British Dyes Ltd., at Huddersfield, and these in turn are small beside the great development which has been staked out. The extensions have not yet come into bearing, and upon the part of the best informed persons there is little disposition to encourage sanguine hopes of a larger supply of dyestuffs during the continuance of the war. The materials, the chemicals, and much of the plant wanted for colour-making are still more urgently wanted for high explosives, and those most in need of more dyes put munitions first. The present output of the works at Huddersfield is allotted entirely to consumers in ratio to their holding of shares in the company. The receipts by any one shareholder are far below his actual needs, but he gets a limited supply of what corresponds to water in a desert at prices controlled by the cost of production. He pays about twice as much as formerly for dyestuffs, for which dealers ask ten or twenty times the old rates, and on the strength of these is able to undertake profitable business which has otherwise to be refused. There are no opportunities at present of embarking on the production of new coal-tar colours, but the time for that departure is coming. Meanwhile, a certain number of goods are being dyed with anilines resurrected from odd corners, and to which neither the user nor the seller can attach a name. The dyed product is sold under the now familiar intimation that the fastness of colours cannot be guaranteed. This disclaimer lifts a load off the dyer's back, and it is apparent that there are dyers now making far more money out of dear dyestuffs than ever they did out of cheap.

Logwood.—The absence of the tar colours has been made tolerable by the presence of the vegetable extracts and chiefly of logwood, on which a new dependence has been placed. Serious fears of a shortage of the supply of logs, dust or haematin crystals, has been allayed by Government action that should ensure shipments from Jamaica. In view of some disposition to beatify logwood, it is instructive to notice how this dye was regarded in 1581, when a statute was passed to prevent its use. To quote the text: "There hathe byn brought from beyonde the Seas a certeyne kinde of Ware or Stuffe called Logwood alias Blockewood wherewith dyvers Dyers doe dye daylye . . . As the Colours made with the said Stuffe ys false and deceiptefull . . . all such Logwood shalbee forfeyted and openlye burnt." Logwood in those times was a scandalous substitute for woad and madder, gallnuts and sumac. In these days logwood provides presentable blacks and more doubtful blues, which the dyer improves by the sparing use of artificial dyestuffs. Madder, after being replaced by synthetic alizarin, is replaced further in some quarters by vegetable indigo, of the fastness of which there is no doubt. Woad, the most ancient of British dyestuffs, is still grown in Lincolnshire, and has been retained in limited use by a few wool dyers uninterruptedly.

The Carpet Business.—The war is understood to have postponed indefinitely a reorganisation of the carpet trade of this country. Carpet manufacturers, with few exceptions, belong to one or other of two trade associations already, and it is hardly a matter for doubt that important economies could be effected by bringing the whole industry under a unified control. It is apparent that too many types of carpet are made in given works to allow of the most economical production of each. Designs are more numerous than are indispensably needed, and, especially in printed carpets, the change of design has an important bearing upon the cost of work. The redistribution of work and the reorganising of the buying and selling departments offer promising scope for economy. If the war imposed no other obstacle the want of dyestuffs would be a sufficient bar to an immediate consummation of the large transaction contemplated. For want of colour, orders cannot

be executed on a scale to satisfy current demand, and the dearness of colour, taken with that of woollen, jute, linen and cotton yarns, keeps carpets at a high price.

Textile Journals.—In this country the technical side of textile journalism has three representatives, and all published in Manchester. The eldest of them, the *Textile Manufacturer* (monthly), had for its first editor the late Mr. Richard Marsden, an enthusiast in everything concerning textile work. Leaving that journal he founded the weekly paper the *Textile Mercury*, and made it the vigorous mouthpiece of employers in all that concerns their trade. The death of the second editor of that journal, Mr. Edward Ellis Marsden, eldest son of the founder, calls for respectful notice. Less of a public figure than his father, Mr. E. E. Marsden was held in the highest esteem. The *Textile Recorder*, founded by the late Mr. J. Nasmith and conducted by his son, is the third of the trio. In America textile journalism has flourished with an abundance certainly not to be matched here or upon the Continent. The *Textile World Record* of Boston, and the *Textile Manufacturers' Journal* of New York, the one monthly and the other weekly, have given respectively the best technical and best market news. They have united to form the weekly *Textile World Journal*, of which the first copies have reached this country. The *Wool and Cotton Reporter* and *Fibre and Fabric*, of Boston, are two other weekly industrial journals. The new monthly journal *Textiles* of Boston, appears in January, and is the venture of Mr. Samuel S. Dale, ex-editor of the *World Record*, an authority of pronounced and refreshing views upon trade politics.

NOTES ON BOOKS.

PRACTICAL ORGANIC AND BIO-CHEMISTRY. By R. H. A. Plimmer. London: Longmans, Green and Co. 12*s.* 6*d.* net.

Good arrangement and concise language, with avoidance of such vague superfluities as now so often serve to increase the bulk of technical books, are characteristics that are evident at a glance, and more detailed examination shows the author as a practical and orderly worker—moreover, a worker who can usefully enlist and guide others.

The author, who is Reader in Physiological Chemistry at University College, refers to the 150,000 carbon compounds that are now known, this remarkable multiplicity being due to the unique property which carbon possesses of being able to group itself or "combine with itself"; but as only a small number of these are concerned with vital processes, and this small number is more or less represented by types or representative substances, it becomes practicable to produce a comprehensive and thoroughly serviceable text-book within reasonable compass.

Laboratory practice, as far as it specially bears on the work of bio-chemistry, is treated of in forty-eight pages, this section giving detailed instructions as to important matters which may have been overlooked in the earlier chemical training of the student, as, for example, distillation, fractionation, and concentration *in vacuo;* the last process being of quite vital importance in relation to nearly all organic liquids that require concentration. We may refer to the somewhat complex apparatus for concentration *in vacuo* depicted on page 14: this is built up of quite usual laboratory appliances, and the sketch is supplemented by almost epigrammatically concise suggestions and instructions. Scarcely less important than evaporation *in vacuo* is the drying of crystals and solids at a controlled temperature under exhaustion, this matter being treated of in a remarkably practical way on pages 20 and 21. The device depicted is a glass vessel like a test-tube (set horizontally) for containing the substance to be dried; this is connected with a receptacle containing phosphoric anhydride, the "test-tube" being heated externally to the required temperature.

Mr. Plimmer's systematic study of bio-chemistry differs from many other systems by making the compound rather than the biological aspect or function the text, and thus he quite appropriately commences with a study of the essentials and the constitution of the hydrocarbons and of their reactions, hydrogenation in the presence of a nickel or platinum catalyst being duly emphasised. As bearing on hydrogenation, we may perhaps be allowed to refer to what may be an important aspect, detailed in the last-published (November 30th, I. p. 933) issue of the *Journal of the Chemical Society*, namely, hydrogenation by a catalyst suspended in an inert liquid, the hydro-carbon (ethylene) and the hydrogen bubbling through.

When our author comes to enzymes, proteins, and the haemoglobins, he perforce has somewhat to modify his plan of leading with the chemical compound rather than the bio-aspect or the function; but the extension of our knowledge in the future may allow of a full and strict application of the author's very desirable system in subsequent editions.

The haemoglobins are treated of with that fullness which the subject justifies, a frontispiece plate showing absorption spectra, and it is interesting to note the remarkably slight difference between the absorption spectrum of oxygenated blood (oxyhaemoglobin) and blood saturated with carbon-monoxide (carboxyhaemoglobin). Although nitric oxide haemoglobin is mentioned in the text the absorption spectrum is not given. It may be conjectured that the remarkable after-effects of inhaling nitrous fumes may be partly due to the inhibiting of the blood-function by the reduction of the higher or "red fume" oxides and formation

of the nitric oxide haemoglobin, this matter having a notable interest at the present time in relation to the war and the effects of the various asphyxiating vapours. On page 478 we find a suggestion that the red colour of meat pickled with potassium nitrate is due to the presence of nitric oxide haemoglobin.

The parallel subject of the chlorophylls is treated of with a commendable thoroughness and with a full appreciation of the most recent researches by Willstätter and his school.

Not many weeks ago we were glancing over Otto Funke's "Atlas of Physiological Chemistry," which was published in 1853 by the Cavendish Society, and our feeling was one of regret that so little use has been made of the store of wealth contained therein—a feeling of regret which is tempered by finding that Mr. Plimmer has drawn freely on this source, and with due acknowledgment.

The book under notice is one which may be studied with profit, not only by the beginner, but also by the most advanced worker, and we hope that the general appreciation will be such as to lead to edition after edition, so as to keep pace with that rapid progress which characterises this branch of chemistry.

THE ANALYSIS OF NON-FERROUS ALLOYS. By Fred Ibbotson and Leslie Aitchison. London: Longmans, Green and Co. 7*s*. 6*d*. net.

According to the preface, the aim of the authors has been to include in one volume such processes of analysis as they consider to be accurate and rapid. Considerable predominance is given to electrolytic methods, and many forms of electrode are mentioned, ranging from "just a loop of moderately stout platinum wire" to "just ordinary platinum crucibles soldered autogenously to a stout platinum wire"—this latter being a remarkable multiple form which we do not remember to have seen in use. Extended surface for the cathode is, we are told, best obtained by using platinum wire gauze, and of the nine forms of electrode that are illustrated three are of gauze.

The estimation of iron in alloys containing only a small proportion is included in the scheme of the work, but as regards non-ferrous alloys generally the range included by no means covers the whole of the industrial ground, leading prominence being given to copper alloys.

Possibly we may be regarded as hypercritical if we say that a rigidly punctilious chemist may object to some of the forms of expression, as, for example, "ammonium hydrate is then added" (p. 137), an expression that suggests the isolation and handling of this elusive and perhaps mythical compound. Similarly vague is the "few drops of ammonia" on the same page. In each case an aqueous solution of ammonia is doubtless intended.

In a future edition there may be an elimination of some of the less important matter to make room for the inclusion of a wider range of metals as used in the industrial non-ferrous alloys.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m. :—

JANUARY 19. — LAWRENCE CHUBB, "The Common Lands of London: the Story of their Preservation." LORD FARRER will preside.

JANUARY 26.—J. ARTHUR HUTTON, Chairman of the British Cotton Growing Association, "The Effect of the War on Cotton Growing in the British Empire."

FEBRUARY 2.—S. CHARLES PHILLIPS, M.S.C.I., "Paper Supplies as affected by the War."

FEBRUARY 9.—PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

FEBRUARY 16.—THE HON. LADY PARSONS, "Women's Work during and after the War."

FEBRUARY 23.—MISS H. B. HANSON, M.D., B.S., D.P.H., "Serbia as seen by a Red Cross Worker."

INDIAN SECTION.

JANUARY 13. — COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., late Survey of India, "The Romance of Indian Surveys." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

FEBRUARY 17.—C. A. KINCAID, C.V.O., Indian Civil Service (author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.), "The Saints of Pandharpur." LIEUT.-COLONEL SIR DAVID W. K. BARR, K.C.S.I., will preside.

MARCH 16.—PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

Dates to be hereafter announced :—

R. W. SETON-WATSON, D.Litt., "The Balkan Problem."

CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

REV. P. H. DITCHFIELD, "The England of Shakespeare."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

VICTOR HORTA, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

CHARLES DELCHEVALERIE, "Belgian Literature."

PROFESSOR T. G. MASARYK, "The Slavonic Peoples."

G. P. BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmyn, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

INDIAN SECTION.

Thursday afternoons at 4.30 p.m.:—

April 6, May 18.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

February 1, March 7, May 2.

CANTOR LECTURES.

Monday afternoons at 4.30 p.m.:—

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m.:—

REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "Flemish Architecture." Three Lectures.

February 7, 14, 21.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

JUVENILE LECTURES.

These Lectures will be given on Wednesday afternoons, January 5 and 12, at 3 p.m. The first lecture will be given by Professor John M. Thomson, LL.D., F.R.S., on "Crystallisation," and the second by Mr. James Swinburne, F.R.S., on "Science of some Toys."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 3...Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 3.30 p.m. (Juvenile Lecture.) Mr. R. Connor, "Canada and the New Empire."

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. 1. Dr. R. Seligman and Mr. P. Williams, "The Action of Boiling Acetic and other Acids on Aluminium." 2. Mr. S. G. Sastry, "The Action of certain Chlorinated Hydrocarbons on some Metals in the presence of Moisture." 3. Messrs. C. Savill and A. W. Cox, "The Viscosity of Oils in the Redwood and Ostwald Viscometers." 4. Mr. R. C. Frederick, "The Estimation of Carbon Dioxide in Air by Haldane's Apparatus." 5. Mr. F. H. Newington, "A method for the determination of free Caustic Alkali in Soap." 6. Exhibition of Chemicals and Apparatus.

Geographical Society, Town Hall, Kensington, W., 3.30 p.m. (Juvenile Lecture.) Mr. H. C. Woods, "Constantinople."

TUESDAY, JANUARY 4...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Professor H. H. Turner, "Wireless Messages from the Stars." (Lecture IV.)

Röntgen Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8.15 p.m. 1. Mr. J. H. Gardiner, "Some Observations upon the Occurrence of Uranium." 2. Exhibition of Specimens and Apparatus.

WEDNESDAY, JANUARY 5...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. (Juvenile Lecture.) Professor J. M. Thomson, "Crystallisation." (With experiments.)

Geological Society, Burlington House, W., 5.30 p.m. Mr. E. B. Bailey, "The Islay Anticline (Inner Hebrides)."

Child Study Association, University of London, South Kensington, S.W., 5.30 p.m. Dr. C. W. Saleeby, "Saving the Future."

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 3.30 p.m. Mr. W. H. Garrison, "The Wonders of the Antipodes."

Sanitary Engineers, Caxton Hall, Westminster, S.W., 7.30 p.m. Presidential Address.

THURSDAY, JANUARY 6... Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Professor H. H. Turner, "Wireless Messages from the Stars." (Lecture V.)

Optical Society, at the Chemical Society, Burlington House, W., 8 p.m. Mr. S. D. Chalmers, "The Use of a Graticule in Binoculars and Telescopes."

FRIDAY, JANUARY 7...Geographical Society, Town Hall, Kensington, W., 3.30 p.m. (Juvenile Lecture.) Mr. P. M. Roxby, "Pictures of China and Korea."

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 3.30 p.m. Miss G. Bacon, "Flying Machines in Peace and War."

Geologists' Association, University College, W.C., 8 p.m. Dr. C. W. Andrews, "The Discovery and Excavation of a large specimen of Elephas Antiquus."

SATURDAY, JANUARY 8...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Professor H. H. Turner, "Wireless Messages from the Stars." (Lecture VI.)

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FRIDAY, JANUARY 7, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 12th, 3 p.m. (Juvenile Lecture.) JAMES SWINBURNE, F.R.S., "The Science of some Toys."

THURSDAY, JANUARY 13th, at 4.30 p.m. (Indian Section.) COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., late Survey of India, "The Romance of Indian Surveys." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

BOOKS OF TICKETS.

Fellows are reminded that they have the privilege of giving admissions to all the Society's meetings to two friends, and a book of the usual tickets for the purpose will be sent to any Fellow who will apply for it to the Secretary.

JUVENILE LECTURE ON "CRYSTALLISATION."

On Wednesday afternoon, January 5th, Professor John M. Thomson, LL.D., F.R.S., delivered the first Juvenile Lecture, the subject being "Crystallisation."

Professor Thomson commenced by describing the various conditions under which material substances are found in Nature—gaseous, liquid, plastic, and solid — pointing out the gradual passage of one condition into the other; this passage depending greatly on changes of temperature. He stated that for the purposes of the lecture that afternoon his remarks would relate to the solid condition of matter, and more particularly to certain properties in those substances which assume definite crystalline form.

Some general properties belonging to crystals were then described, and experiments shown illustrating the different effects exercised by them on a beam of light, either plain or polarised. Slides were exhibited on the screen showing the effects of double refraction, and the colours produced by various crystalline substances when viewed by polarised light.

Professor Thomson next spoke of the various ways in which crystals may be produced; illustrating these experimentally in the formation of crystals by sublimation, and their deposition from states of fusion and solution. He pointed out the necessity for the component parts of the crystallising substance having great freedom to move, so as to assume the crystalline shape, and therefore that deposition from a state of solution may be regarded as the most convenient and common method for obtaining crystals. After describing what is meant by hot and cold saturated solutions in connection with the solution of salts, the lecturer exhibited crystals depositing from their solutions in different forms. Models and diagrams of the various forms of crystals were shown. The difference between hydrated and anhydrous salts was explained. The relation of water to the composition and sometimes to the colour of the salt when combined with it was illustrated by the distillation of blue vitriol ($CuSO_4 . 5H_2O$); when the colour of the blue crystals disappeared and clear water was distilled from the salt, the forms of the crystals also disappearing during the distillation. The reunion of water with the dried mass was shown, when the blue colour was, to a certain extent, restored, but the crystalline shape could not be reformed till the salt had been redissolved in water and allowed freedom to crystallise. The physical circumstances accompanying the union of water (*a*) with an anhydrous salt, and (*b*) with an already hydrated salt, were explained; the heat evolved in the first case being experimentally

contrasted with the cold produced in the second. Methods other than by heating for the removal of water from salts were shown, such as the addition of a third substance to the solution of a salt, which uniting with the water originally combined with the salt abstracts it, causing the deposition of the salt in an anhydrous condition. Further experiments were shown on the relation of colour to the composition of crystalline bodies by means of the various colour changes seen in the salts of the metals cobalt and nickel, changes originally used in sympathetic inks. That change in colour might take place without apparent change in composition was proved by heating the red crystalline variety of mercury iodide, which at once changed to a yellow variety. On allowing this to cool and rubbing with a hard substance, the crystals at once revert to the red variety. When the particles of the crystalline salt are widely separated from each other by solution the colour may disappear, and the solution become colourless. On the separation, however, of the salt in the crystalline condition on cooling, the original colour reappears. This was shown in the crystallisation of yellow lead iodide from a clear hot solution of that substance in water.

The lecturer then described certain cases in which the solution of the crystalline salt in water, and its deposition therefrom, departed somewhat from the normal conditions of crystallisation. He drew attention in these exceptions specially to the cases of common salt, which is almost as soluble in cold as in hot water; to calcium sulphate, which is less soluble in hot than in cold water; and to Glauber's salts, which increases in solubility up to a temperature of 33° C., and then decreases. At that temperature the salt $Na_2SO_4 . 10H_2O$ is said to have its point of maximum solubility. He showed that if a solution of this salt be prepared at that temperature, and when hot tightly stoppered, the solution would on cooling remain liquid without the deposition of any crystals. On opening the flask however, when cold, and allowing the air to enter, crystallisation at once begins, and the whole mass ultimately is deposited in the crystalline form. This constitutes the phenomenon of so-called supersaturation. It was then shown that it was not necessary to have the flask closed by a cork, but that if stoppered instead with a plug of cotton-wool, which filtered the air as it entered the flask whilst cooling, the same result could be obtained. The cause of this sudden solidification in such solutions has attracted much attention. That it is not due to shaking could be shown by blowing air from the lungs through the solution, when no crystallisation took place; but on blowing unfiltered air from a pair of bellows, crystallisation very soon occurs. Evidently some nucleus is required, and Professor Thomson proceeded to show experimentally the nature of the nucleus which proved active in starting this crystallisation. Substances cut into the same crystalline shape as that of the salt in solution, or even crystals themselves, if they are of a different crystalline form from the salt in solution, are *inactive* to the solution; but a crystal of the substance itself which is in solution is invariably *active* in promoting solidification. Other salts, provided they are truly isomorphous with the salt in solution—that is, having the same crystalline form and a similar chemical structure—are also *active* in causing crystallisation. As illustrating this point, interesting experiments were shown in which layers of supersaturated solutions of different salts, one above the other in long tubes, were crystallised by nuclei consisting of crystals of the salts present in each different layer. Crystalline salts may thus be separated from mixed solutions of dimorphous salts by the action induced by their respective nuclei. Professor Thomson concluded by showing certain physical phenomena connected with the solidification of these solutions; more particularly the great evolution of heat which takes place in the passage of the liquid to the solid condition, this being contrasted with the experiment shown at an earlier part of the lecture, demonstrating the production of cold by the conversion of a solid salt into a state of solution.

On the motion of the Chairman a hearty vote of thanks was accorded to Professor Thomson for his interesting lecture, and the meeting terminated.

THE WORLD'S SUPPLIES OF FUEL AND MOTIVE POWER.*

Industrial Civilisation requires Coal, Oil, and Motive Power.†—The present civilisation of the

* Extracted from the Thomas Hawksley Lecture, delivered before the Institution of Mechanical Engineers by Dugald Clerk, D.Sc., F.R.S., on October 29th, 1915.

† Just before delivering this lecture, my attention was called to an able work entitled "Natural Sources of Energy," by Professor A. H. Gibson, D.Sc., of University College, Dundee. This interesting work was published in 1913, and in it is discussed the problem of the fuel and motive power of the world in a careful and comprehensive manner. The results given here agree generally with Professor Gibson's conclusions, although arrived at independently from somewhat different data.

world rests upon a basis of coal and oil fuel, and water, steam, and internal-combustion motive power. At the middle of the eighteenth century the United Kingdom had but the small population of ten and a half millions. It was only entering into the stage of transformation from a purely agricultural country to the first great industrial community of the world. Previous to that time motive power had only been available to a small extent, as provided by water and wind. True, the Newcomen steam-engine then existed, but its use was strictly limited. In the third quarter of that century the work of James Watt raised steam-power from a wasteful process to a relatively economical one; and in the first instance the early Watt engines were entirely used for pumping out mines. The development of the steam-engine by Boulton and Watt was thus continued, and necessitated by the needs of the hydraulic engineer.

The coal consumption of Newcomen's engine was about 20 lb. per i.h.p., while that of Boulton and Watt was from 5 to 7 lb., about one-fourth to one-third of the pioneer engine.

Engineers' later efforts greatly improved upon these figures; thus triple-expansion engines require 2 lb., large steam-turbines 1½ lb., and suction gas-engines 1 lb. per i.h.p.

The success of the Watt steam-engine enabled coal-mining to be firmly established and coal output increased; and this increase of output was accompanied by the rapid invention and application of numerous mechanisms and processes leading to the plentiful production of iron, steel, textile fabrics, chemical manufactures—soap, alkali—the whole mechanism, in fact, required for the existence and comfortable subsistence of the rapidly increasing population of these islands, which in 1801 had risen to over fifteen and a half millions.

The steam-engine was rapidly applied to stationary purposes, driving mills and works of various kinds, then to marine engines, and last of all to land locomotives, and by the middle of the nineteenth century in its reciprocating form it had firmly established itself as the greatest source of motive power for man's use. The low cost of coal and the large amount of power obtained from steam for small capital and running expenditures at first made it unnecessary to think of economising too closely. As time went on, however, the amount of power required rapidly increased. For example, at the beginning of the nineteenth century the steam-power developed in stationary engines in the whole kingdom did not amount to more than 4,000 h.p., and even in 1836 an engine developing 40 h.p. was considered a very important undertaking. In 1836 this power had risen to about 30,000 h.p.

The Committee of Managers of the Birmingham Philosophical Institution published a report on October 3rd, 1836, which gave, among other things, a statement of the steam-power employed in Birmingham in 1835; it amounted in all to 2,700 h.p. divided among ten industries, and employed 4,000 men and 1,300 women.

Total Power of Industrial Engines in Great Britain in 1907.—In the first census of production for the year 1907, the total power of industrial engines in use in Great Britain and Ireland is given as 10,578,475 h.p., and the steam-engine power of road rollers and road locomotives owned by public authorities amounted to 167,192 h.p. Of the industrial engines, steam reciprocating engines were rated at 9,118,818 h.p.; steam turbines, 530,892; internal-combustion engines, gas, oil, etc., 680,177; and water power, 177,907 h.p. The persons employed in the factories using this large power numbered nearly 10½ millions; so that, roughly, the power available for the industries of Britain was nearly 1 h.p. per person employed. To support the 46 millions of people now living in the United Kingdom thus requires a continuous enormous expenditure of power, and a very large consumption of fuel.

The total coal known to be in existence in the world is given by Mr. D. B. Dowling as 7,397,553 million tons, and the total output of the whole coal of the world in 1913 was 1,363,878,110 tons. Assuming that rate of consumption to continue, obviously we have over 5,400 years' supply.

The Report of the Royal Commission on Coal Supplies, issued in 1905, as the result of an elaborate investigation, gives the contents of the proved coal-fields of the United Kingdom as 100,000 million tons, and estimates coal in still unproved fields as 40,000 million tons. If one can assume them to realise 25,000 million tons, then at the present yearly consumption of 250 million tons we have still 500 years' supply.

In the year 1903 the output of coal from Britain was, in round numbers, 230 million tons. Of this, about 168 million tons were consumed in the country and 62 million tons exported. Much of this exported coal, however, was used for coaling purposes for British steamers abroad. Under these circumstances it becomes highly important to the country at large, and very interesting to the engineer, to consider what can be done, first, to reduce the rate of use of our coal to a minimum, and second, to study how motive power is to be procured and industry carried on in a coal-less Britain.

In evidence given before the Royal Commission, Dr. G. T. Beilby, F.R.S., makes the interesting calculation that out of an annual consumption of from 143 to 168 million tons of coal, there is a possible saving of from 40 to 60 million tons. I have taken Dr. Beilby's figures for the higher consumptions mentioned, and calculated from his division the percentage used for each separate purpose in the table on page 140.

Dr. Beilby's estimated saving is thus 60 out of 168 million tons annually, 35·7 per cent. of the portion used for home consumption, or 26·1 per cent. of the total, including the exported coal, and it increases the coal life of our country to

676 years. Dr. Beilby pointed out in a note published eight years later by the British Science Guild, that the large gas-engine had not developed so rapidly, and the steam-turbine had advanced more rapidly than expected, so that the savings he anticipated had not yet been circumstances we should be forced to dispense with it. But even if we allow 12 million tons of the 36 to be still used for radiation, the total coal bill would be reduced to one-half, and the industrial life of the country increased to 1,000 years. From this it appears that our present

——	Consumption in Millions of Tons.	Percentage.	Possible Saving.	How Saved.
Railways	14	8·4	7	Electric traction.
Steamers	8	4·7	—	——
Factories	45	26·8	30	Gas generators and engines.
Mines	12	7·2	7	Gas-engines and recovery ovens.
Blast-furnaces	18	10·7	3	,, ,, ,, ,,
Iron and steel	12	7·1	3	Gas generators and coke.
Other metals	2	1·2	—	——
Brickworks, potteries, glass and chemical works	6	3·6	2	Gas generators.
Gas works	15	8·9	—	——
Domestic purposes	36	21·4	8	Gas cooking, heating, briquettes and coke.
	168	100·0	60	

realised. Even without the superior thermal efficiency of the internal-combustion engine, large steam-turbines generating power at central stations are capable of reducing the 45 million tons of coal required for power in factories to nearly Dr. Beilby's figure.

Under pressure of necessity, however, it will prove possible to make other economies, which, however, involve greater changes. Thus, exhaust heat from steam- and gas-engines is utilised at present to a certain extent in heating buildings and carrying on various manufacturing processes, but no comprehensive attempt has been made to supply motive power, light and heat from the combustion of the same fuel. Large central stations with gas-generators and high efficiency gas-engines would give all the motive power required for factories on 15 million instead of 45 million tons of coal, as shown in the table; but even then the waste heat from water-jacket, exhaust gases, and gas-producers equals that produced by burning 10 million tons. This distributed through a city as steam at 30 lb. or so pressure above atmosphere could readily supply heat for the household to warm the rooms and perform cooking operations. The high efficiency of steam-heating and cooking would enable the heat of 10 million tons to do the domestic work at present performed by 36 millions. The open fire would be missed, with its pleasing radiation, but under pressure of fuel-needs might be met by the use of half our coal consumption. Further economy may be effected by the extended adoption of water-power.

In order to reason with any approach to accuracy, it is necessary to arrive at some probable estimate of the total power available in the world, and to extend the inquiry not only to a coal-less England, but to a coal-less and oil-less world. The total energy available to us is due to solar radiation, past and present, tidal energy, and the earth's internal heat. The great source of all our energy is, of course, solar radiation. Taking Sir J. J. Thomson's estimate of 7,000 h.p.* per acre as the total radiation of the sun absorbed on the earth's surface with a clear sky, this is sufficient to produce 4,480 h.p. per square mile, assuming an absolute efficiency of conversion of one-tenth per cent. Such a result, however, can only be hoped for in desert districts, where the sun's rays are not obstructed by clouds or vapour. If this enormous energy were easily available, then engineering problems would chiefly deal with the generation of motive power in great deserts such as those existing in Africa, and the transmission of the power so generated to districts where man could live and pursue his manufactures.

* Professor A. H. Gibson gives the value as 8,000 ft.-lb. per minute per square foot in areas between the Equator and 45° North and South latitudes.

Sun Power.—Though many engineers, including Ericsson, have experimented with sun engines,* so far no method of using the direct solar energy of radiation has been invented which is capable of supplying any large amount of power. The world, however, may be considered as a huge solar engine, in which the waters of the seas are evaporated by the heat absorbed, and much of the vapour carried to high levels, at which it is deposited as water, and flows down to the sea. By this process we get a complete cycle of operations, including evaporation of water into steam, condensation of the steam into water, evaporation again, and so on. In falling from the high level to the low level of the sea, power can be obtained from this water. Hydraulic power, in fact, is a form of sun power, and will continue in existence long after all the coal and oil in the world have been exhausted. Coal and oil have also been produced by the action of the great solar engine, and they contain a proportion of the energy of radiation of past ages, stored up in the growing wood and leaves of plants; accumulations which are now being rapidly drawn upon by mankind. Coal and oil are thus the result of past radiant energy, while wind and water-power are due to present radiant energy. In one case the store in the earth is being used up and cannot be replaced; in the other case, so long as the solar system lasts, power exists also. Mr. Ellington very clearly took this view in the first Hawksley Lecture, when he said: "On a review of the whole subject, it appears that water-power is likely to become increasingly important. It is perennial in its source. As a mechanical agent it has numerous ramifications, which are constantly extending, and its direct application to industry offers a large field for the exercise of the talents of the inventor and the engineer."

Increasing Importance of Hydraulic Power.—Although I have devoted myself to the rival power obtained by internal combustion, I thoroughly agree with what Mr. Ellington has said. Undoubtedly as time goes on, hydraulic power must become of increasing importance. Mr. Ellington estimated the average rainfall in the United Kingdom as 25 in. per annum, and he calculated that, assuming a fall of 500 ft., this gave 100 h.p. per square mile continuing throughout the year. But a small part of the area of the United Kingdom is at so high a level as 500 ft. The total area of the United Kingdom is roughly 121,000 square miles. Taking suitable ground of 500 ft. level at 5 per cent. of the total area, and assuming it possible to construct artificial lakes by means of dams, from this area nearly two million h.p. could be obtained, available for eight hours per day every day of the year. In some areas of England the rainfall is more than 60 in. per annum, and on these areas the altitude is about 1,000 ft.

* Professor Gibson gives an account of recent solar motor experiments.

Mr. Alexander Newlands, Chief Engineer of the Highland Railway, read a most interesting Paper before the British Association in 1912, on Scottish Water-Power, in which he adopts the view of Professor G. Forbes, F.R.S., that the available hydraulic power in Scotland exceeds one million h.p. Mr. Newlands has investigated many convenient power stations, and gives a list of forty-five localities, from which he considers a total of 205,000 h.p. could be obtained. He states that the Kinlochleven Works of the British Aluminium Co., on the west of Argyllshire, cost £600,000, and develop 30,000 h.p., at a capital expenditure of £20 per h.p. The total cost of current used is one-sixteenth of a penny per unit, after allowing for interest on capital and depreciation.

The average investment cost of all American water-powers he gives as £40 per h.p. developed. Mr. Newlands comes to the conclusion that installations costing up to £20 per h.p. could deliver power at a cost with which no steam plant could hope to compete. In Norway and Sweden, where Pelton wheels are used, with high heads, installations exist which cost £10 per h.p., and in these countries power has been advertised for sale as low as thirty shillings per h.p. per annum. Mr. Newlands quotes the *Electrical Review's* comparison of the minimum costs of an electrical horse-power per annum from

	£	s.	d.
Water in Switzerland	1	19	0
Steam in England	4	11	8
Blast-furnace gas in Germany .	4	1	7
Producer-gas in England . . .	5	0	0

From these figures, it is evident that in Scotland, even at the present time, hydraulic power presents economic advantages when compared with power obtained from the cheap coal of to-day by steam- and gas-engines. With increasing scarcity of coal, undoubtedly hydraulic power will in the future show greater advantages, and even in England and Ireland it might be possible to earn interest on capital expenditure greater than £40 per h.p. By great engineering works, it might be just possible to obtain perhaps three million h.p. from areas which could be given up for the purpose. This power obviously is insufficient for British needs.

To increase production, other sources may be drawn upon. In the conditions assumed, the only other source of energy at all comparable to water is the yearly fuel growth of trees and undergrowth. It is difficult to arrive at any probable value of wood growth in the United Kingdom. The whole area under forests is 3,081,754 acres, and I can find no published figures dealing with annual yield. The total area of German forests is given as 34,569,800 acres, and the yearly yield as 26,183,410 cubic yards of timber, and 23,348,640 cubic yards of

firewood. Taking a cubic yard of firewood as weighing 0·6 ton gives 14 million tons as the annual growth of firewood in Germany. This equals 6,200,000 tons of coal in heating value. The forest area of the United Kingdom is about one-eleventh of that of Germany, so that on this scale we could only produce heat equal to 563,000 tons of coal. Obviously firewood growth with us cannot be expected to give more than about 350,000 h.p. No doubt larger areas will be devoted to forests in the future, and greater power obtained, but I fear even then the yield could not make up for the loss of coal. There only remains wind and tidal power for consideration. Wind power may be neglected. Tidal power, however, would add materially to the total, but at the cost of great, inconvenient, and expensive works.

Oil does not materially affect our problem. The total oil produced from wells and distilled from shale in the world is about 5 per cent. of the weight of coal raised, and according to Sir Boverton Redwood, even if the whole of the crude petroleum were employed as fuel, in steam raising, it would not replace, allowing for its high thermal value, much more than 5 per cent. of the world's output of coal; while if used in internal-combustion engines, it would be equivalent as a source of power to about 15 per cent. of coal. Only a small proportion, however, of the crude petroleum can be regarded as available for use as a source of power, for by far the larger part is in demand as an illuminating agent, and as a lubricant for machinery.

Sir Boverton Redwood states also: "Some of the older oil-fields of the United States are becoming exhausted, and Dr. David T. Day, of the United States Geological Survey, considers that at the present rate of increase of the output of petroleum, the known oil-fields of that country will, on the basis of the minimum quantity of oil obtainable, be exhausted by the year 1935, whilst even if the present output were only maintained, the supply would, on the same basis, not last for more than 90 years." The oil supply of the world, accordingly, does not greatly help us to extend the duration of industrial civilisation. The earth's heat—the only other source of power—is unavailable, and could not be drawn upon in our present state of knowledge. In the absence of coal, then, it appears that all the energy available for power in the United Kingdom would not exceed 4 million h.p., or 6·5 million h.p. less than is at present used in our factories alone.

But we also require fuel to produce power for railways and ships. In the table (page 140) railways use 8·4 per cent. and factories 26·8 per cent. of our total coal consumption. Assume that locomotives require the same weights of coal as factories for each horse-power developed, then the locomotive power of our country is about 3·3 million h.p. Our mercantile marine requires another 5 million h.p., and the Royal Navy in time of war also requires 5 million.

Altogether, to carry on the industrial civilisation of these islands in time of peace, on the scale of to-day, absorbs a power of about 19 million h.p., and without coal we could only obtain 4 million. Obviously, a change of condition such as this necessarily involves great modifications in our social life and a large reduction in the population which we can support in comfort.

Taking 1,100 million tons as the world's output of coal for 1907, on the assumption that the proportion used for factories and railways is the same as in our country, then the world's factories require 295 million tons, and railways 93 million tons. Assuming the same consumption per h.p., the world's factories require 60 million h.p., and the world's railways 19 million. I have estimated the power of the world's shipping as—mercantile marine, 10 million h.p.; warships, 13 million h.p. The total power used in the world generated by the combustion of coal is thus of the order of 100 million h.p.:—*

	Million h.p.
World's factories	60
World's railways	19
World's ships	23
	102

This estimate does not include existing hydraulic power. Assume it to be 13 million h.p. Then the total power required in a coal-less world would be 115 million h.p. There is little doubt that the hydraulic supply of the world† is capable of producing more than this, so that even when our world's coal is exhausted all the power required will be forthcoming. In this case, however, storage batteries must be greatly improved to enable ships to be propelled electrically. But as about 40 per cent. of the world's coal is consumed in producing motive power, 60 per cent. of the heat value of the total coal must be replaced from some other source. The only further source of heat would then be growing wood; a large quantity would be grown in tropical countries and transported as charcoal, but fuel so obtained would be expensive, and heat and chemical action in domestic and metallurgic use would be economised to the utmost.

It is very evident, therefore, from this short discussion, that the line of the engineer's duty is to be found in economising all the energy remaining in these islands in the form of coal, and thus postponing the period of industrial change in England. Engineers have long felt the pressure of this duty, and have strenuously

* Professor Gibson gives the same figure, 100 million h.p., but arrives at it in a different way.

† Professor Gibson's estimates of the total available water-power of the world is 200 million h.p.; United States of America water-power from 35 to 55 million h.p., of which 5·3 million were utilised in 1908.

endeavoured to find means of obtaining power at less and less fuel cost; so that even while Watt and Boulton were still struggling to make the condensing steam-engine a commercial success, others were experimenting with various schemes which did not require the use of steam. In these days it was felt that part of the loss of energy experienced in obtaining motive power by steam was due to the latent heat of the steam in passing from the liquid to the gaseous state. This was true in a limited sense, but the science of thermodynamics had no existence until about 1840, and accordingly engineers had nothing to guide them in determining the laws by which heat produces mechanical work. The idea, however, that latent heat absorbed heat energy undoubtedly had its effect in provoking attempts to use atmospheric air as a source of motive power.

Stirling and Ericsson's Hot-Air Engines.—The earliest hot-air engine which was reasonably successful was the invention of a clergyman, Dr. Stirling. In this engine air was heated at constant volume with increase in pressure, and the power was obtained by subsequent expansion. In another engine of what is now known as the constant-pressure type, Ericsson, the well-known American engineer, compressed air, heated it at constant-pressure, and expanded it in a larger cylinder than the compression cylinder. In both the Stirling and the Ericsson engines a contrivance known as the regenerator was used, which was the subject of much controversy and misunderstanding. The early Stirling engine was produced in 1815, but thirty years after a paper was read by Mr. James Stirling at the Institution of Civil Engineers upon "Stirling's Improved Air Engine." The main improvement consisted in working with air at a greater original density than that of the atmosphere, and the engine had so far succeeded that two had been used at the Dundee Foundry Co.'s works, one giving 21 h.p. and the other 45 h.p. Mr. Stirling claimed that the 21-h.p. engine required only 2½ lb. of coal per h.p. hour. This is an extraordinarily good result, and could only have been obtained by the action of the regenerator. It is clear, however, from the paper and from the discussion, that many engineers then imagined that, with a perfect regenerator, no heat would disappear in performing work. The speakers in this discussion included Robert Stephenson, and, curiously enough, he plainly misunderstood the whole process of action of Stirling's engine. His remark on the regenerator was illuminating: "He understood the process to consist of heating the air in a vessel, whence it ascended to the cylinder between numerous thin laminæ, by which the caloric was absorbed, to be again given out to the descending air. Now, it appeared to him that, though the ascending process was natural and easy, the reverse action would require a certain expenditure of power, in the depression of the plunger." A Mr. Cottom said: "It was evident that if it was practicable to arrive at the theoretical condition of the absorption of all the caloric by the thin laminæ during the upward passage of the air and the giving it out again during the downward passage, there would not be any loss of heat."

Other papers were read on the same subject at the Institution of Civil Engineers in 1853, and the discussion interests us particularly, because Mr. Thomas Hawksley joined in it. Mr. Hawksley considered that the machine involved a mechanical fallacy, and that the regenerator produced no mechanical effect whatever. Here Hawksley was clearly in error, but he erred in good company, because at the same time the famous Dr. Faraday said: "Twenty years ago he had directed his attention to this question, and from theoretical views he had been induced to hope for the successful employment of heated air as a motive power; but even then he saw enough to discourage his sanguine expectation, and he had, with some diffidence, ventured to express his conviction of the almost unconquerable practical difficulties surrounding the case, and of the fallacy of the presumed advantages of the regenerator." Brunel also considered the use of the regenerator to be an entire fallacy. Sir George Cayley, about the same time, described another hot-air engine, which may be considered as the first of the internal-combustion type acting with solid fuel under constant pressure. In his engine he pumped air into a furnace, and led the heated products of combustion through valves into the interior of a cylinder. He also was unsuccessful. The Stirling and Ericsson engine worked, but both engines were extremely bulky and heavy. Ericsson built a hot-air engine for operating the hot-air ship "Ericsson" in America, and the cylinders were no less than 14 ft. in diameter. From these he got only about 300 h.p. Both types of engine failed, because of the rapid burning out of the cylinder bottoms with the direct action of the fire, as it was found impossible to heat the air rapidly enough to the required temperature without maintaining the temperature of the metal surfaces much higher than the maximum temperature to be attained by the air. Some inventors, as has been stated, proposed to heat the air by combustion, and Cayley's was the first attempt to do this with solid fuel. Cayley, however, introduced difficulties as grave as external heating, hot gases had to pass through pipes and valves to the motor cylinder, and this made it impossible to maintain a high temperature without damage to the machine.

Inventors dealing with internal combustion introduced into a cool cylinder a mixture of gas or inflammable vapour and air at atmospheric pressure, ignited this mixture at constant volume, and drove a piston by the increase

in pressure. Professor Farish, of Cambridge, at his philosophical lectures at the University, exhibited a model engine so operated as early as 1817. Other inventors attempted to operate their engines by atmospheric pressure, producing the necessary vacuum or reduction of pressure by the combustion of an inflammable gas in air.

The Cecil Engine.—The Rev. W. Cecil, M.A., of Cambridge, read a paper in the year 1820 before the Cambridge Philosophical Society, on the application of hydrogen gas to produce a moving power in machinery, with a description of an engine which is moved by the pressure of the atmosphere upon a vacuum caused by explosions of hydrogen gas and atmospheric air. He described an engine which he had constructed to operate on the explosion vacuum method. He thus explains the principle of his engine: "The general principle of this engine is founded upon the property which hydrogen gas mixed with atmospheric air possesses of exploding upon ignition so as to produce a large imperfect vacuum. If two and a half measures by bulk of atmospheric air be mixed with one measure of hydrogen and a flame be applied, the mixed gas will expand into a space rather greater than three times its original bulk. The products of explosion are, a globule of water formed by the union of the hydrogen and the oxygen and the atmospheric air and a quantity of azote, which, in its natural state (or density, 1) constituted 0·556 of the bulk of the mixed gas. The same quantity of azote is now expanded into a space somewhat greater than three times the original bulk of the mixed gas—that is, into about six times the space which it occupied before; its density is therefore about one-sixth, that of the atmosphere being unity. If the external air be prevented by a proper apparatus from returning into this imperfect vacuum, the pressure of the atmosphere may be employed as a moving force nearly in the same manner as in the common steam-engine; the difference consists chiefly in the manner of forming the vacuum."

The operation of the engine consisted in drawing into the cylinder a proportion of atmospheric air and hydrogen, igniting this mixture at the end of the stroke, allowing the hot gases to be discharged from the cylinder by the pressure of combustion, then cooling the gases in the cylinder and producing a vacuum to operate the piston.

Mr. Cecil stated that the engine rotated at 60 revolutions per minute: in practice it was found to work at considerable power and perfect regularity. In the model constructed, the engine used 17·6 cubic feet of hydrogen gas per hour. Evidently, however, the engine was rather noisy, because the inventor stated: "To remedy the noise which was occasioned by the explosion, the lower end of the cylinder A, B, C, D, may be buried in a well, or it may be enclosed in a large air-tight vessel." This engine is very crude, but extremely ingenious. It is also interesting to note that Cecil made experiments by which he determined approximately the maximum pressure produced by means of a mixture of hydrogen and atmospheric air. He gives this maximum pressure as 180 lb. per square inch absolute.

The Brown Engine.—Mr. Cecil did not carry his invention further, but another inventor, Mr. Samuel Brown, took out patents in 1823 and 1826 in which he operated by filling a vessel with flame to expel its contained air and throwing in a jet of water to condense the flame. This produced a partial vacuum, and the atmospheric pressure was made available for utilising the power by means of an ordinary piston. Samuel Brown was very persevering, and according to the *Mechanics' Magazine* published in London in August, 1824, he had then made a model which raised 300 gallons of water 15 ft. high on one cubic foot of gas. In 1832 it appears that four of his engines were in use for pumping:—(1) One at Croydon at the canal, raising water from a lower to a higher level; (2) one at Soham in Cambridgeshire, for draining part of the middle fen district; (3) one at Eagle Lodge, Old Brompton; and (4) one at Eagle Lodge, Old Brompton, of the beam type. It was stated that the cylinder of the Croydon engine was 3 ft. 6 in. in diameter by 22 ft. high. Engine No. 3 was inspected by the editor of the *Mechanics' Magazine.* Its cylinder was 3 ft. 8¾ in. diameter by 22 ft. high; and it discharged 750 gallons per stroke, four strokes per minute, 12 ft. high. Brown claimed in a circular published in 1832 that the coke and tar obtained in making coal gas for the Croydon engine were sold for such sums as produced a profit in addition to giving motive power for nothing. He stated that the whole annual expense of the Croydon gas vacuum engine, including coal, wages, repairs, depreciation, rent, amounted to £666 14*s.* 0*d.*, while the receipts from the sale of coke and tar were £769 12*s.* 0*d.*, so that the annual profit was £102 18*s.* 0*d.*, without counting the value of the pumping work done, which previously cost the Canal Co. £275 per annum to effect by steam-engine. This state of affairs, however, could not have been permanent, as after some years of work the engines were displaced. Brown also applied his vacuum gas-engine to driving a carriage in 1825 and to propelling a boat on the Thames in 1827. These early attempts were obviously inspired by the low-pressure steam-engine with its vacuum obtained by steam, but no real success was attained, the gas consumption—that is, the consumption of heat for producing a given power—being very high.

Lenoir Gas-Engine.—Meanwhile the work of Joule, determining the mechanical equivalent of

heat, taken together with that of Macquorn Rankine, Thomson and Clausius, based partly on the earlier investigations of Carnot, had developed a definite theory of the relationship between heat and mechanical work. Accordingly, we find the advocates of internal combustion increasingly active, and in 1860 Messrs. Marinoni introduced in Paris the famous Lenoir gas-engine. In it the principle is exceedingly simple and evident. The piston moved forward a part of its stroke by the energy stored in the fly-wheel, and took into the cylinder a charge of gas and air at the ordinary atmospheric pressure. The valves cut off communication, and the explosion was occasioned by electric spark. The piston was thus propelled to the end of the stroke. Exhausting was performed exactly as in the steam-engine. This engine was practicable but very uneconomical. It was largely used, however, for pumping. One such engine was inspected by the author at Petworth House, Petworth, in 1882, and it had then been working, pumping water, for about twenty years. This engine was replaced some years ago by an engine of the National Gas Engine Co.'s manufacture, which was used both for pumping and electric lighting.

The Engines of Otto and Clerk.—It was very soon found that, to obtain economy in an internal-combustion engine, compression was necessary, and the history of the modern internal-combustion engine dates from Beau de Rochas' famous pamphlet in 1860, in which the alternate use of a cylinder as pump and motor and the use of considerable compression was fully described. To the late Dr. Otto, however, belongs the honour of bringing this type of engine into practical use. This he did in 1876. Otto's was the first compression gas-engine to succeed in practice. I produced my first compression engine in 1878, and exhibited it at work at the Kilburn Royal Agricultural Show in 1879. In this engine compression was also used, but an impulse was obtained at every forward stroke of the motor piston. The engine best known, however, as of the Clerk type was not produced till 1881, in which year it was exhibited at an Electrical Exhibition in London and later in Paris. This engine was the first in which the piston overran ports by which the exhaust was discharged, and where the charge was admitted to the cylinder from a separate pump in such a way as to discharge the exhaust products before it. Practically all the internal-combustion engines of the world now operate either on the Otto four-stroke or on the Clerk two-stroke system. In these engines the explosion takes place at constant volume, so that the pressure rises.

Constant-Pressure Engine.—As far back as 1873 a constant-pressure engine was introduced by an American inventor, Brayton. This engine resembled a hot-air engine in which air was compressed into a reservoir at a constant pressure, then expanded into a working cylinder at the same pressure, and the volume increased by the formation of flame. Brayton's engine used light petroleum, and it had a certain success. It had considerable application for stationary work, and it was intended to apply also to the propulsion of boats and vehicles. The modern constant-pressure engine, however, does not work in the Brayton manner. The Diesel type depends upon the compression of air to about one-twelfth of its original bulk in a cylinder, the raising of the temperature of the air to a sufficient extent to ignite heavy oil when injected into it in fine spray. The injection occurs from the beginning of the stroke during a very small advance of the piston on its forward stroke. A diagram is thus produced which is substantially a constant-pressure diagram. This engine is extensively used for many purposes, including pumping. It sometimes operates on the Otto and sometimes on the Clerk cycle. The smaller engines use the Otto method and the larger the Clerk method.

Comparison of Steam and Internal-Combustion Engines.—During many years, compression was continuously increased in constant-volume types of engine, and with increased compression came increased economy of fuel. At the same time coal-gas was supplemented by other gaseous fuels; first, Dowson pressure-gas made from anthracite, then suction-gas from anthracite, coke and other fuels, and later waste gases from the blast-furnace. Many substances also were utilised to produce gas for engines, many of them waste products, sawdust, dried peat and wood chips of different kinds. Bituminous fuel was also used, at first only in conjunction with ammonia-recovery processes; later, on a smaller scale, for gas only.

Many obstacles were found to increasing engine dimensions indefinitely. In the early days of the internal-combustion engine, enthusiastic pioneers like myself considered that ultimately the internal-combustion engine would entirely displace steam. In a paper read at the Institution of Civil Engineers in 1882, I stated: "The gas-engine is as yet in its infancy, and many long years of work are necessary before it can rank with the steam-engine in capacity for all manner of uses; but it can quite well be made as manageable as the steam-engine in by no means a remote future. The time will come when factories, railways, and ships will be driven by gas-engines as efficient as any steam-engine, and much more safe and economical of fuel. Gas-generators will replace steam-boilers, and power will not be stored up in enormous reservoirs but generated by coal direct as required by the engine.

"The steam-engine converts so small an amount of the heat used by it into work that, although it was the glory and honour of the

first half of the century, it should be a standing reproach to engineers and scientists at the present time having constantly before them the researches of Mayer and Joule."

Other engineers like Sir Frederick Bramwell shared in this feeling. Sir Frederick even went so far as to predict that, by 1931, steam-engines would only be found in museums. A gallant attempt was made by those interested in the gas-engine to fulfil Sir Frederick's prophecy, and very great progress has been made. The internal-combustion engine has acquired a definite position in the engineering world, and shares largely with the steam-engine in the power production of the world. Progress, however, has revealed conditions of unlooked-for advantage in the steam-engine which so far has not been attained in internal-combustion engines. The advent of the steam-turbine, developed by the genius and indefatigably hard work of the Hon. Sir Charles Parsons, has proved clearly that, for large powers, reciprocating pistons operating in cylinders must become a thing of the past.

In the early days of the compression internal-combustion engine (about 1880) the average efficiency of the steam-engines in use was very low. In Britain an average steam-engine of medium size would usually be found to convert only 5 per cent. of the total heat of the coal burned under the boiler into indicated work in the engine-cylinder. The best result obtained, even with large reciprocating steam-engines, about that time did not exceed 10 per cent., calculated in the same way. The early Otto cycle gas-engines of the same date converted 16 per cent. of the total heat of the coal-gas used into indicated power within the cylinder. As years went on this efficiency was greatly improved upon, and about 1910, internal-combustion engines of 15-in. diameter cylinder, when carefully made, could be relied upon to give an indicated thermal efficiency of 35 per cent., and in some experimental tests even so high as 40 per cent. has been obtained. At one time it was believed that as gas-engine cylinders increased in diameter, efficiencies would also increase, because of the diminished proportional surface causing less heat-loss from the hot flame to the enclosing walls. It was found, however, that increase beyond 15-in. cylinder diameter produced but little practical change in actual indicated thermal efficiency. Careful investigation into the phenomena of the gas-engine cylinder by many investigators, including the present author, proved conclusively that little gain could be expected from further increase of cylinder dimensions. Much scientific work had been done by the British Association Committee on Gaseous Explosions and by Committees of the Institution of Civil Engineers and of the Institution of Mechanical Engineers. These investigations clearly proved that definite properties of the working fluid limited the thermal possible efficiencies, so that if even the whole heat-flow through the sides of the cylinder be put an end to, only a moderate increase in indicated thermal efficiency would result. Distinct limits to increased thermal efficiency were shown to exist. The conditions, however, of heat-flow within the cylinder were more and more clearly understood, and were found to be greatly affected by cylinder dimensions; increased cylinders prejudicially affected the power of the cylinder-jacket and piston to dissipate the heat of the explosion and so tended to undue rise in wall temperature. In other words, it was found that the larger the cylinder became, the greater became the difficulty of preventing heat fractures in breech-ends, cylinders, liners, and pistons. It was speedily found that in the ordinary four-stroke or Otto cycle-engine, 22 in. to 24 in. was the safe limit of cylinder diameter for engines having unwatered pistons. Immediately these dimensions were exceeded, it became necessary to pump water through a hollow piston and also through the exhaust-valve, in order to keep down wall temperature and avoid fracture and pre-ignitions. Although watering a piston does not appear to be a formidable operation, yet it inevitably increases the weight of the piston and reciprocating parts of an engine, and so diminishes the possible piston-speed by increasing the stresses due to the acceleration and retardation. Engines as large as 51-in. diameter cylinder have been made, but the weight required per horse-power was very greatly increased. The law of similar structures shows clearly that for entirely similar engines of increasing cylinder dimensions, the weight per indicated horse-power increases directly with the cylinder diameter. This is true of steam- as well as of gas-engines, but the gas-engine is at a disadvantage because the ratio between maximum and mean available steam-pressure is much more favourable than that between maximum explosion and mean pressure; and, further, the double-acting steam-engine for a single piston produces two impulses per revolution, while a double-acting four-stroke engine requires two revolutions within which to produce two impulses. Accordingly, the weight of a gas-engine for a given power is greater than that of a steam-engine of equal cylinder diameter. A gas-engine is thus necessarily heavier than a steam-engine of the same power and cylinder dimensions. The law applies even with greater force to engines of the Diesel type, where pressures of compression of 500 lb. per square inch must be provided for, and a sufficient margin must be left to allow for even 1,000 lb. per square inch, due to explosive instead of constant-pressure ignition, which sometimes occurs, especially when starting. All these difficulties tended to restrict the commercially saleable internal-combustion engine to moderate powers.

On the Continent engine-builders favour large cylinder slow-running engines of great weight; but in England such engines never became really popular, and the great gas-engine trade of Britain has been built up on the basis of a cylinder not exceeding 24-in. diameter usually running with an unwatered piston and exhaust-valve. In England the multiple cylinder high-speed internal-combustion engine has had considerable success, and is now made by well-known engineering companies in sizes up to about 3,000 h.p. for one engine.

In reciprocating steam-engines for fast battleships and passenger steamers, the limit of weight for power was approached about 1895, and it became evident that, if higher speeds were required, some other method of obtaining motive power must be adopted. Sir Charles Parsons began his work on the land steam-turbine in 1884, and began experiments on the marine steam-turbine in 1894, and in a marvellously short time he passed from the engines of the "Turbinia," giving 2,000 shaft h.p., to the engines of the "Mauretania," giving 70,000 shaft h.p. It was speedily proved that the steam-turbine in various forms gave large powers within limitations of weight impossible by any other method. Powers of 100,000 h.p., for example, now frequently found in battle cruisers, such as the "Lion" and "Tiger," could not have been obtained from reciprocating steam-engines at all; still less could such powers have been obtained from internal-combustion engines of any type, whether gas or Diesel oil. Further improvements in gearing the steam-turbine to its propeller enabled the weight of the turbine to be greatly reduced, and its speed of rotation arranged for maximum efficiency, while allowing the speed of rotation of the propeller also to be arranged for maximum efficiency. Consequently the turbine became more and more economical.

In the early days of the small steam-turbine the steam consumption was large, but now Sir Charles Parsons is able to offer a large power turbine with a steam consumption as low as 9 lb. per shaft horse-power. In such an engine 20 per cent. of all the heat of the steam is converted into shaft horse-power, and with a boiler of ordinary efficiency this may be taken as giving a return of at least 15 per cent. of the whole heat of the fuel in useful work transmitted by the shaft. It was speedily found that these large turbine engines gave but little trouble in the engine-room compared with their reciprocating predecessors, and as a result the Parsons steam-turbine has become in a few years supreme in all battle fleets; indeed, if the total horse-power upon the seas of the world be taken as about 24,000,000 h.p., 8,000,000 h.p. is accounted for by the Parsons turbine.

The difficulties found to accompany increasing cylinder dimensions have thus limited the internal-combustion engine to comparatively small units; a 5,000-h.p. engine is considered very large for any form of gas-engine; a 5,000-h.p steam-turbine forms an ordinary unit for an electric light station engine. Obviously the internal-combustion engine must be considerably modified before it can equal the steam-turbine as a mechanism for producing large powers. As a machine for converting heat into work, the internal-combustion engine is still supreme; but engineers must now devote themselves to overcoming the mechanical difficulties of very large powers. It is possible to increase the thermal efficiency still further, but gain in that direction will not help us in our competition with the steam-turbine. So far as I can see, there is no hope of an indefinite increase in power using reciprocating pistons. Something must be done to introduce the rotary principle. Many attempts have been made to produce a gas-turbine, the most important recent attempt being that of Mr. Holzwarth, whose gas-turbine has been built by Messrs. Brown, Boveri and Co.; but, so far as I know, no success has yet been attained. The theory of the Holzwarth turbine in its form last known to me necessarily gives a somewhat low thermal efficiency; I have calculated it to be 15 per cent. of the heat of the working fluid, and in 1912 the extreme value claimed by Mr. Holzwarth was 23 per cent. Such results do not practically improve upon those of the largest steam-turbines.

Other methods, however, of dispensing with the reciprocating piston and cylinder are quite practicable. The large Humphrey pump described in the second Thomas Hawkesley Lecture dispenses with pistons, and utilises an explosion-chamber in which gases are compressed and ignited, and operate by throwing a heavy column of water into motion. This method has advantages, but it is necessarily heavy for a given power. It appears possible to use water in another manner by filling a chamber, exploding a compressed mixture above the water, and forcing the water through a jet to operate a turbine of the Pelton type. Arrangements would be made to allow for the varying velocity of the water due to fall of pressure by expansion, and it would be quite possible to obtain an efficiency between explosion-chamber and Pelton wheel of about 80 per cent. Such a turbine could be made to work using the same water repeatedly, and high efficiency combined with light weight is possible. A brake efficiency of 30 per cent. is possible. Experiments in this direction are worthy of consideration. Before such engines could compete for the highest powers reached by the steam-turbine, gas-producers must be considerably modified and improved. The Mond type producer using bituminous fuel has been fairly successful, but it depends largely for success on the recovery of ammonia, and this involves a bulky and heavy plant. This is

allowable in stationary installations, but for marine purposes much lighter and smaller producers would require to be designed capable of consuming bituminous fuel as completely as is done in a steam-boiler furnace, so that but little tar ever exists in the gas. If tar once gets into gas, an enormous scrubbing plant becomes necessary. Producers will require to be designed and experimented with which avoid the huge scrubbing plant required at present in all bituminous producers. With such producers and such engines a brake efficiency of 25 per cent. between fuel and Pelton wheel would not be difficult to obtain, and a 30 per cent. efficiency is quite possible.

With such mechanisms built in large power units, the power of Britain could be obtained for nearly one-third the present fuel consumption, and the work of the gas-engineer would thus materially aid in prolonging the coal life of Britain.

Progress of Indicated Thermal Efficiency.—So far the work of the engineer during the nineteenth and twentieth centuries has resulted in improving the indicated thermal efficiency from 3·8 per cent. obtained by the Boulton and Watt condensing low-pressure steam-engine to 35 and 40 per cent. obtained by explosion and constant pressure internal-combustion engines. The following table shows the progress very clearly :—

the engine. In comparing modern efficiencies, therefore, the steam-turbine shows 18½ per cent. heat conversion from the fuel against 28 per cent. heat conversion from fuel by gas-producer in the explosion gas-engines. From this it would appear that, even against the best steam-turbine, a very substantial advantage would be gained if internal-combustion engines were made of similarly high efficiency operating on the continuous rotating principle. This, however, is a matter for future development, and offers an excellent field for the young and ambitious engineer. At present the power in use by steam-turbine, both on sea and on land, is greatly in excess of that produced by stationary internal-combustion engines.

From what I have already said, it will be seen that engineers' efforts have been continuously directed for about 150 years towards increasing the thermal efficiency of their prime movers; and in this quest for greater economy they have adopted a working fluid, flame, much more difficult to deal with than the early working fluid, steam.

When fuel becomes more and more expensive as our coal supply becomes obviously lessened, organised attempts will be made to obtain economies which are not worth while so long as coal is cheap. Dr. Ferranti, in a presidential address to the Institution of Electrical Engineers, some time ago, dealt with the possibility

INDICATED THERMAL EFFICIENCY OF STEAM AND INTERNAL-COMBUSTION ENGINE.

		Indicated Efficiency. Per cent.
Steam.		
Boulton and Watt condensing low-pressure, about 1820		3·8
Cornish engine, about 1850		9·0
Triple expansion, about 1910		17·0
Parsons turbine, about 1914		23·0
Internal-Combustion.		
Lenoir, about 1860		4·0
Compression—Constant volume (two or four stroke)	1876	16·0
	1905	35·0
Compression—Constant pressure (Diesel), 1910		40·0

The indicated efficiency refers to the proportion of the total heat of the steam or working fluid given to the engine converted into indicated work. The indicated work obtained for 100 heat units in the fuel is, of course, less because of boiler and steam-pipe losses; and, where a gas-producer is used, because of gas-producer losses. Assuming a very favourable figure for the efficiency between the boiler and the steam-cylinder, 0·8, it will be seen that the indicated efficiency from the heat in the fuel in the case of the Boulton and Watt engine is only 3 per cent., and in the case of the explosion internal-combustion engine 28 per cent. Applying the same correction to the Parsons turbine, we get 18½ per cent. as the best result of heat conversion from fuel to the shaft horse-power of

of economising for both power and heat by the electric conversion and conveyance of all the fuel energy. He showed the advantages of large central stations distributing electric current at a very low price—he mentioned one-eighth of a penny per unit—applying this current for all the purposes of heating, lighting and motive power. So long as fuel is cheap, no doubt Dr. Ferranti's scheme might be usefully put into operation; but when fuel becomes really dear, too much heat is lost in the process of conversion into electric current. Central stations could be established in which steam-turbines were used for generating electric power, and where the exhaust-steam from the turbine was discharged at a pressure above that of the atmosphere, so as to maintain the temperature above 100° C.

Such turbines would not give the thermal efficiency now obtained by Parsons, because they would lack the long expansion used by him in his largest and most efficient machines. The exhaust heat, however, could be used for manufacturing purposes and for household heating in a city, and a combined heating and thermal engine could thus be produced whose theoretical efficiency was 100 per cent.; the only loss would be that due to conduction during distribution, but heat supply for a city for heating houses and for doing low temperature manufacturing work could be readily obtained from the waste heat of the steam-turbines at the central stations. A large part of the heat necessary for comfortable life and industry could thus be obtained. Where medium high temperatures were required, a gas of low calorific value could be distributed, and efficient furnace arrangements could be made to obtain the necessary temperatures with a maximum economy. The waste heat from such furnaces could also be used to raise steam to enable general heat distribution to be conducted. Under these conditions many chemical processes, such as smelting, would be conducted electrically, with only such weight of carbon as was necessary for the chemical reaction—the high temperature for the reaction would be given by the electric heating. By combinations of steam-power and internal-combustion engines and exhaust heating, using both engine exhaust and furnace discharge, great economies would be effected and fuel consumption would be very greatly reduced. Dwelling-houses would be heated by circulating steam or hot water up to a certain temperature, and the added radiant heat necessary for comfort would be obtained either electrically or by burning small quantities of coal or gas in suitable fires. Although such conditions favour a low efficiency use of steam for motive power, yet at a further scarcity price of fuel the high efficiency in the internal-combustion engine would find its field, because, broadly, a greater electrical heat and light could be obtained with a given fuel consumption, and the engine exhaust-gases would be at a higher temperature, and so have heat in a form available for a greater number of manufactures than the low temperature steam.

Future of Hydraulic Power.—Long before the final exhaustion of coal-pits, the increased expenditure necessary for heating and motive power would increase the pressure upon the hydraulic engineer, and undoubtedly much greater use would be made of water-power. I have already referred to Mr. Ellington's interesting calculation as to the total water-power of Britain determined by assuming all the rainfall to be available from a level of 500 ft. above the sea, except that portion required for the use of the population, and absorbed by vegetation and evaporation. Mr. Ellington calculates on this basis that 35 million horse-power would be available for 2,000 hours in the year. If this could be done, of course, Britain, except for marine purposes, could be independent of coal. This calculation, however, requires two-thirds of the area of England to be arranged at the high level of 500 ft. as a huge storage tank for rain-water, but with our present knowledge such an area is an engineering impossibility.

The future interaction of the world's three great prime movers—water, steam, and internal combustion—is very difficult to predict and appreciate. The effect, for example, of importation of coal from outside sources can hardly be predicted.

Whatever happens in the future, however, we may rest assured that hydraulic power will play a most important part, and that what has been called the "White Coal of the Mountains" will assume greater and greater importance with the increasing age of an industrialised world. In an able paper read at the Zürich Meeting of this Institution in 1911, Mr. L. Zodel concludes with this statement: "Members of the Institution of Mechanical Engineers are indeed the representatives *par excellence* of steam and steam power. Water-power, the 'White Coal of the Mountains,' will hardly be of much importance in their own country, compared with that all-powerful 'Black Queen of Energy' of which they have an abundance; but it may, indeed, play a very great part in the development of the resources of the vast colonial possessions composing the British Empire." Undoubtedly Mr. Zodel saw clearly; but as time goes on Britain itself will become more and more dependent on hydraulic power.

Meantime, by the application of high-efficiency engines, the use of all waste heat for domestic and industrial purposes, and the application of all available water-power, all on a large scale, the engineer may extend the industrial period in England to over one thousand years. Long before that period our dominions across the sea will have become huge nations exceeding the 100 million souls as predicted by Professor Seeley, and even a coal-less England will remain great and prosperous, the intellectual and strategic centre of a vast empire.

Altogether the engineers of the future have before them vitally important and interesting problems, and on the success of their work depends the future of our country—whether we can support, five hundred years hence, an industrial population of fifty millions, or an agricultural one of about twenty millions. Of our immediate future I have no fear. We shall assuredly uphold our liberty and independence, notwithstanding all the warlike efforts of the Germanic powers; but our distant future undoubtedly depends more on the efforts of engineers than on the labours of war or politics.

PEAT AS A SOURCE OF FUEL OIL.

The value of peat deposits as a source of fuel has been in part recognised for hundreds of years; but up to recent years it has been unrecognised, even by men of science, that the greater part of that value was wasted in the uses to which peat was put. Everyone who has travelled in Lanarkshire or in Kerry, to name but two of the many "peaty" regions of this kingdom, must have noticed the bare patches on the moors where "turf" has been cut, and the piles of peat turfs, resembling walls of brown unbaked bricks, which form the harvest of the moor. Sometimes these heaps belong to the landowner, sometimes to the peasantry, under rights of "turbary," which are dealt with in many old feus and leases and in statutes of the realm. Many of us have tried peat blocks as an economical addition to our coal fires, and those of us who have gardens have known the advantage of peat-dressing for the ground in which rhododendrons, for example, are planted. Quite recently the horticultural world has been stirred by the published accounts of the production of giant potatoes, flowers, and other vegetables and plants through the use of a fertiliser invented by Professor Bottomley, which is composed of prepared peat inoculated with a certain species of bacteria. This last use of peat represents highly specialised chemistry, as compared with the burning of crude peat blocks as fuel, or the mixing of crude peat with garden mould.

But, at the present juncture, when the difficulty of providing sufficient fuel to keep factories in full work, to supply motive power for ships of war or of commerce, for railway traction, and for domestic use, has presented a serious problem to the Governments of nearly every civilised State (not to speak of the Central States of Europe), the hitherto neglected quality of peat as a source of *highly refined* fuel, both solid and liquid, is the principal subject of interest in connection with this member of the great fuel-producing quartette of natural resources—wood, coal, oil, and peat.

A chief point in connection with peat, which is quite ignored by the general public, is that oil can be produced from it. Not only is it oil-producing, but the oil which can be and is now being distilled from common peat is one of the finest and purest oils that can be obtained for burning in quantities sufficient for any practical purpose. By the scientific treatment of peat, waste has now been almost completely abolished, and under the best process of preparation now available, the peat—previously macerated to break up the cells and dried in the form of briquettes—is converted into charcoal, ammonia, acetic acid, acetone, and methylic alcohol, as well as a gas which is used, without other fuel, to heat the retorts in which the distillation of the peat is carried out.

The charcoal which remains as the solid residuum, after the distillation of the peat briquettes, is of special value, in that it is not only of great heating power, but contains very little sulphur, a consideration which must impress anyone accustomed to the use of coal or coke. But, in this particular respect, the same advantage may be claimed for wood charcoal.

It is when we come to consider the oil produced in the chemical breaking-up of peat that the immense importance of the new discoveries with regard to the treatment of this natural product becomes apparent.

We have seen that oil is one of the specific results of the process. Now let us see what are the possibilities—realised in daily practice—of this oil. On further distillation it is itself subdivided into light oil, fuel oil, paraffin-wax, phenols, and pitch. The light oil is useful for internal-combustion engines; the paraffin-wax can be used for any purposes in which good paraffin-wax is generally employed; the pitch is just pitch, and is no more or less useful than other pitches. But the really notable resultant is the fuel oil. This is produced of a quality to meet the specification of the British Admiralty for naval fuel oil. More than that, it has an immense advantage which the Admiralty had not hitherto found it possible to include in its specification—it is, like the charcoal, practically devoid of sulphur.

The absence of sulphur in a fuel oil eminently suitable for naval engines is of immense importance to the health and comfort of the engineers and firemen in all cases, and of the whole crews in the case of destroyers and torpedo boats. The misery produced by the fumes emitted from the furnaces when the fuel contains an appreciable proportion of sulphur may readily be imagined by anyone who has himself burned sulphur in a room or store for the destruction of moth, and has opened the door to see how the stuff was burning. The lungs are suffocated, the eyes are inflamed by this penetrating smoke, and the human victim feels for a time that he would rather all the germs and moths should do their worst than that he should suffer such intense discomfort. Yet the stoker in the engine-room of a ship where sulphurous fuel is burnt—as it commonly is in small, swift-going naval craft—has to endure a similar discomfort nearly all the time, and this discomfort is often shared by half the crew who happen to be employed below deck, particularly in the space behind the engines. Not only does the health and efficiency of the human factor suffer much from sulphurous fumes from the oils hitherto in use in our Fleet, but the mechanical factor, the engines themselves, suffer a constant deterioration from the same cause. For every reason it is desirable that the oil containing the minimum of sulphur should be employed.

For naval purposes, therefore, not only on the score of efficiency as a fuel, but of economy of health and humanity, the peat oil is ideal. As to cost, the price at which it is being already produced is satisfactory, and the price at which it will be produced when large supplies are demanded, and great quantities of peat are brought under

treatment, will be considerably less than it is in the present circumstances of restricted manufacture.

As for the supply of the raw material it is, so far as anyone now living is concerned, or any likely demand within present purview, practically inexhaustible. It is true that, in spite of the fact that the neglect of all but the surface peat has, up till recently, left the lower masses to become richer year by year in those constituents from which oil is now being produced, there has been appalling waste during centuries past, if, indeed, that can truly be described as waste which was due to the absence of any possible means of prevention in the existing state of knowledge. But there should be waste no longer. The peat moors of Scotland, of Northern England, of Ireland and Wales, and of France, where vast tracts of peat lie about La Vendée, for instance, and in other regions well known to specialists in the new process, will almost certainly be brought under the control of men who will know how to develop to the utmost for national purposes these rich gifts of Nature hitherto so lavishly misused.

Dr. F. Mollwo Perkin, in his recent Cantor Lectures before the Royal Society of Arts on the "Production and Manufacture of Mineral Oils," added much to the general information accessible to the public on that question.

The waste of timber forests in England and the New World has been most lamentable, and in Western Europe France alone has, during a century past, cared or known how to treat her woodlands economically. That she will treat her peat moors economically now that their value is better understood seems certain. In any case, let us hope that as our oak forests were in the past depleted to provide material for our ships of war in the ages of "Wooden Walls," so, in this age of steel, our peat moors may be, not depleted, but scientifically treated, for the provision of motive power for those vessels which are doing so much to maintain that command of the seas which the frigates largely helped to secure.

W. H. Helm.

FOREST RESERVES OF CANADA.

According to a report just issued by the Canadian Government, the total area of the forest reserves of the Dominion in 1914 amounted to 152,935,593 acres, divided among the provinces as follows :—

Province.	Acres.
Quebec	107,997,513
Ontario	14,430,720
Manitoba	2,606,400
Saskatchewan	6,195,705
Alberta	16,813,376
British Columbia (in railway belt)	2,417,638
" " (outside of railway belt)	2,474,241

Besides the areas given for British Columbia, all lands west of the Cascades bearing more than 8,000 ft., board measure, of timber per acre, and all lands east of the Cascades bearing more than 5,000 ft., board measure, of timber per acre, are removed from entry.

It is stated that considerable care has been exercised in including in these reservations only lands which control watersheds, or which have been found unsuitable for agriculture.

USES OF THE PALMYRA PALM.

An unusual variety of uses has been found for the palmyra palm tree (*Borassus flabelliformis*), the list being so extensive that every part of the tree has been turned to some use.

Its five fibres are used in making various products, its timber is valuable, and it contributes to medicine and food supply.

The palmyra palm is tall, with a cylindrical stem. It grows all over tropical India, and is occasionally seen as far north as latitude 30°. It is especially abundant in all sandy tracts near the sea, on embankments around tanks, and in the mixed coconut and date-palm jungles of Bengal. The palmyra forests of Tinnevelli form a distinctive feature in the scenery of the Province. The greater part of the Indian export trade in palmyra goes through the port of Madras.

The five fibres include one about 2 ft. in length, which may be separated from the leaf stalks, and is used for making rope and twine, and sometimes for paper; a loose fibre, which surrounds the base of the leaf stalk; one called "tár," which may be prepared from the interior of the stem; a coir derived from the pericarp; and the fibrous materials of the leaves.

The leaf fibre is used especially in the manufacture of the basket-ware of Madras, and is put to a great variety of other uses by the natives. Fine strips of the leaves, especially prepared and dyed, are plaited into braids and worked up into fancy boxes, cigar cases, etc. At Diamond Harbour, near Calcutta, hats have for many years been made of this material and sold to European sailors.

According to a report by the United States Consul at Calcutta, a few years ago investigations were started in India with a view to ascertaining to what extent the cord-like fibres of the palmyra might be utilised in brush-making, as a substitute for the American "piassava" fibre and the Ceylon "kittul" (*Caryota urens*), but without much success, apparently, as imports into India during the year 1913-14 included 313,070 dozen brushes and brooms, with a total value of £42,500. The leaves are used for thatching huts, for making fans, and in Bengal long strips of the leaf are employed by the children as washable slates.

The timber of the palmyra is the most extensively used of all the palm family. It splits easily, but is said to be able to stand a greater cross-strain than any other known timber. It is used for boat-making, water-pipes, and various domestic purposes. A small export trade is done in the

wood for making walking-sticks, umbrella-handles, rulers, etc.

In medicine, the juice of the palmyra is used as a stimulant, and when freshly drawn and taken regularly acts as a laxative. The root is regarded as cooling, and the ash of the spathe is given for enlarged spleens.

In connection with its use as food it is stated that one-fourth of the inhabitants of Northern Ceylon are dependent on this tree for subsistence, and in Tinnevelli and various communities of India large proportions of the population are supported by it.

The most important food product is the juice obtained on tapping the flower stalk. This juice may be used fresh as a beverage or allowed to ferment, which it does after sunrise, and then becomes an intoxicating liquor. If this liquor is distilled, it becomes palm wine, and by destructive distillation a good vinegar is obtained.

The fresh juice may be boiled down into a sugar called jaggery, which is one of the chief sugars of South India, especially Tinnevilli. It is also an important source of sugar in Burma. The tapping does not injure the tree. The toddy drawer, climbing the tree, tightly binds the spathes with thongs to prevent their further opening, and then thoroughly bruises the embryo flower within to facilitate the exit of the juice.

This operation is repeated for several days, and on each occasion a thin slice is taken off the spathe to facilitate the running of the sap and to help prevent it bursting the bound spathe. About the eighth day the sap begins to exude into an earthen pot placed for the purpose. The pots are emptied twice a day, and a coating of lime inside the pot will prevent fermentation.

Four or five quarts per tree per day is the yield for four or five months. Once in every three years the sap-drawing process is omitted, as otherwise the tree would die. The tree begins to yield at fifteen years, and continues for about fifty years.

The female tree yields about twice as much sap as the male. Three quarts of this sap make one pound of sugar or jaggery. The sweetness of the Burmese bread is caused by the use of toddy juice as a yeast.

The tree flowers in March, and the young fruits are formed in April and May, ripening in July and August. The seeds are eaten as well as the fruit. A seed bed is prepared, and the nuts planted as close together as possible about June or July. At least fifty seeds are planted to the square yard, and in about four months are dug up. The nuts by that time have germinated, and the sprout or young seedling is eaten as a vegetable. The nut itself is broken open and the embryo within eaten dry or is made into a flour that is not unlike tapioca.

In normal times the gross value of a crop per acre, at ordinary market rate, ranges between £1,200 and £2,000.

The following figures, which were compiled by the Department of Statistics, Commercial Intelligence Department of Calcutta, from returns furnished by the collector of customs at Madras, show the quantities of palmyra fibre exported from the Madras Presidency during the last three fiscal years:—

Exported to	1912-13.	1913-14.	1914-15.
	cwt.	cwt.	cwt.
United States . . .	2,149	1,845	5,329
United Kingdom . .	17,820	10,471	39,070
Ceylon	758	924	3,396
Canada	—	20	—
Australia	175	69	257
Germany	31,989	31,228	16,510
Netherlands . . .	5,465	7,820	2,620
Belgium	24,516	25,527	8,961
France	1,725	1,420	2,283
Austria-Hungary . .	—	—	1
Denmark	300	—	100
Norway	—	13	—
Italy	1	—	2
Russia	42	73	—
Japan	1,848	1,030	1,838
Total	86,788	80,440	80,367

ENGINEERING NOTES.

Proposed Indian and Ceylon Railway Connection.—The extension of the narrow gauge of the main lines of India to the extremity of Rameswaram Island, and of the broad-gauge Ceylon State Railway to Talie-manar have been completed. There still remains, however, a break of about twenty miles in the railway connection, over which traffic is conveyed in ferry steamers, but, according to the Administration Report on the Railways of India for 1914–15, provisional plans have now been drawn up for filling this gap and completing the railway over Adam's Bridge. "The proposal is to construct a solid embankment or causeway on the islands and sandbanks of Adam's Bridge, from Danushkody Point on the Indian side to Talie-manar Point on the Ceylon side. About seven miles of this causeway would be built on the dry land of the various islands, and would consist of low banks of sand pitched with coral, presenting no difficulties in construction. The remaining thirteen miles through the sea would

be constructed on a double row of reinforced concrete piles driven into the sand, pitched at 10 ft. centres, and having their inner faces 14 ft. apart. The piles would be braced together longitudinally with light concrete arches and chains, and transversely with concrete ties, struts and chains. Behind them slabs of reinforced concrete would be slipped into position, the bottom slabs being sunk well into the sea bottom and the space enclosed by the slabs filled with sand. The top of the concrete work would be carried 6 ft. above high water, and the rails laid at that level. It is anticipated that the suspended sand brought up by the currents would settle on each side of the causeway and eventually link up Rameswaram and Manar Islands. The total cost of the causeway and the works at the two terminal points of the present railways is estimated at about 111 lakhs of rupees, equivalent at par to £740,000." It is to be hoped that this estimate will include the broad gauge and rectify the mistake made in carrying the narrow gauge into Southern India.

Railway Development in Nigeria.—This has been, states a recent consular report, as rapid in the last few years as in any part of West Africa. The railway system, which is controlled by the British Colonial Government, now extends nearly 800 miles into the interior. The ocean terminus is at Lagos, the main seaport of the colony. The main line runs in a north-easterly direction for 712 miles to Kano, the principal town in the Mohammedan States of Northern Nigeria. From Minna Junction is a branch south to Baro at the head of the permanently navigable section of the River Niger, while a second branch, opened a year ago, runs from Zavia to Bukeru, reaching rich tin deposits. The entire system is of 3 ft. 6 in. gauge.

A Notable Achievement in Wireless Telephony.—The transmission of speech over the 4,600 miles that separate Arlington, Virginia, from Honolulu is likely to rank as an important advance in the development of wireless telephony. Thanks to the ingenuity of various inventors there are ample means of getting a large amount of energy radiated from the antennæ at such frequencies as 50,000 periods per second, which are sufficiently high to prevent audible vibrations in the receiver, and yet capable, by their far less rapid variations in intensity, of transmitting articulate speech. The success of the recent experiments shows clearly that the difficult problem of wave telephony—the control of a sufficient amount of energy by the transmitting device—has been successfully solved, but by what means this has been done has not yet been disclosed. For several years past it has been possible to get a sufficient output of energy at the proper frequency, and the receiving apparatus is relatively a simple matter. To produce, however, a telephone transmitter capable of impressing the necessary modifications of current intensity on a large scale has proved to be a very troublesome matter. Obviously wave telephony over great distances will meet with the same difficulties as wireless telegraphy as regards the effects of atmospheric conditions, and yet it is a solution of many problems of transmission of intelligence. It makes it possible to hold communication with ships over the whole width of the Atlantic and with isolated islands. In as much as speech can be passed on from a wire line to a wireless section, and then again to the subscriber, one can imagine, for example, calling up a correspondent in Bermuda or the Azores as comfortably as across the street. Of course, messages sent out can, as far as we know at present, be heard by anybody who can tune in on the required frequency, which is inconvenient for some purposes. On the other hand, the receiving station can, with considerable success, limit its reception of messages to those coming from a particular station.

Geared Locomotives.—These engines have been very successful in hauling trains on steep gradients and in shunting yards with sharp curves. Geared locomotives were put into service some time ago by the Australian Oil Corporation on a gradient of 1 in 25. More recently two heavy geared locomotives have been purchased for shunting in Kansas City, where the curves and gradients are very severe, the latter varying from 1 in 20 to 1 in 14, on which a load of 170 tons can be hauled. The engines are of the "Shay" type, in which three inverted cylinders are mounted on one side of the firebox. To give flexibility of wheel-base, the engine and tender are mounted on three bogies, all the wheels of which are driven by the engine shaft through flexible couplings and bevel gearing, which permit free curving of the bogies. To allow for the position of the vertical engine, the boiler is offset from the centre line of the track. Each engine with its tender weighs 185 tons.

Tests of Reinforced-Concrete Fence Posts.—Six types of the above posts have been tested under the direction of the committee on signs, fences, and crossings of the American Railway Engineering Association. All posts were made of 1 : 2 : 4 concrete, using broken stone or gravel aggregate not more than ½ in. in size, and were about one year old when tested. Two round, one square, one half-round, one T-shaped, one triangular section were used, all 7 ft. long, all of tapering outline except the last. The reinforcement consisted of various sizes of steel wire or rods, and the lateral dimensions varied from 5 to 6½ in. at the base to 3 or 4½ in. at the top. Impact, cross-bending, and cantilever bending

tests were made. The best results in all cases were given by the round tapering posts, 5½ in. in diameter at the base and 4½ in. in diameter at the top, reinforced with six No. 8 wires. The other smaller circular post, reinforced with five wires, also gave very good results. The tests indicated that this form of post, with several reinforcing wires, or the T-form with three ¼ in. rods, was the strongest and most reliable.

Tall Concrete Poles.—Two reinforced-concrete poles, each 150 ft. high, have been in service over the old Welland Canal at St. Catharines, Ontario, for nine years. Canal rules required a standard clearance of 150 ft. They were found to be in excellent condition, showing no sign of distress. They were designed for a horizontal pull at the top of 2,000 lb., and the steel was considered at this pull to be stressed to its highest permissible limit, 30,000 lb. per square inch. The reinforcement at the bottom consists of four 2½ in. round rods—pins they might more properly be called were their length less. These are decreased in diameter as the stress decreases, the diameter at the top being ¾ in. The concrete is a 1 : 5 mixture, using gravel. Turnbuckles are used to join adjacent lengths, the ends of which are upset. Each pole weighs about 40 tons, and was erected with timber shear legs 96 ft. high, hitches being taken at three points, and the poles were hoisted in a manner similar to a gaff in a sailing vessel.

Three New Turbo-Generators.—The *Times* informs us that the generator portion of a new turbo-alternator, recently ordered by the Commonwealth Edison Company, of Chicago, is said to be the largest 60-cycle machine so far designed. It will be rated at 35,300 kilowatts at 85 per cent. power factor, and will produce three-phase current at 12,000 volts, the speed being 1,200 revolutions per minute. The turbine, of the straight Parsons type, will take steam at 220 lb. pressure and 200° superheat, and its design differs from the large Westinghouse machines, now at work in the Interborough station at New York, in that the entire unit will be placed on one shaft instead of being divided into two crossed compound machines. It is to be ready next autumn. There has recently been installed in the Lots Road generating station of the Underground Electric Railway, a 15,000 kilowatt turbo-alternator, constructed by Messrs. C. A. Parsons & Co. It runs at 1,000 revolutions per minute, and comprises two units, a high-pressure and low-pressure turbine being mounted on the same shaft, with bearings between them. After passing through the high-pressure section of the turbine the steam is led to the centre of the low-pressure unit, which is double bladed, and the exhaust takes place at each end, leading into two separate condensers. The Public Service Company of Northern Illinois, which is affiliated to the Commonwealth Company, has purchased a 10,000 kilowatt, 60-cycle turbo-generator, the turbine of which, of the Curtis type, is distinguished by the fact that its steam supply will have a pressure of 300 lb. per square inch, with a superheat of 200°.

GENERAL NOTES.

British Malaya.—An article under the above title, which appeared in the *Journal* of June 25th, 1915, under the name of George d'Almeida, Portuguese Consul in Singapore, has been found to be a reproduction word for word of an article entitled "Engineering in British Malaya: Position and Prospects," which was published in *Eastern Engineering* of February 19th, 1915. The article was received by the Secretary of the Society direct from Mr. d'Almeida (a Fellow of the Society); there was nothing to indicate that it was not an original contribution from him, and it was accordingly accepted and printed as such. This fact was discovered some months ago, and would have been announced at once, but it was felt that an opportunity should be given to the writer for explanation. No such explanation having been forthcoming, it is felt that the time has come for an apology to be offered to the proprietors of *Eastern Engineering* for an unwitting appropriation of their article.

Electricity in Mines.—The second part of the annual report of the Chief Inspector of Mines and Quarries for 1914, just issued as a Blue-book, shows that the number of electrically-driven coal-cutting machines in use in mines at the end of that year was 1,415, an increase of 108 over the number in use at the end of 1913. During the year nine fatal accidents definitely due to electricity were investigated. Five took place above and four below ground. The report gives the following numbers of persons killed by electric shock underground in coal mines:—1907, ten; 1908, twelve; 1909, thirteen; 1910, fifteen; 1911, nine; 1912, seven; 1913, thirteen; 1914, four; and says the figure for 1914, by comparison with 1913, is very satisfactory, considering that the horse-power of electric plant in use below ground increased by 13 per cent. According to the report the death-rate in mines per million tons of mineral raised was 4·37 during 1914, as compared with 4·91, the average for the decennial period 1905–14.

The German Cement Industry.—This industry has fared badly during the war, according to *Engineering*, and the Halberstadt Chamber of Commerce has, on its behalf, appealed to the military authorities to consider the Central German cement industry in connection with their requirements of cement in the occupied

enemy districts. The Central German cement works have an aggregate annual capacity of 5,000,000 barrels, and a capital of 20,000,000 marks. The export trade, which in ordinary conditions accounts for about two-thirds of the output, has entirely ceased, and the wants of the private building industry are small; during the year not one-fourth of the aggregate production has been sold. The adverse conditions from which the Cement Union suffers will probably continue after the war. For years to come remunerative trading will be handicapped by the forward sales of several works not belonging to the union. Amongst the unhappy Kartel agreements must be reckoned that with the blast-furnace cement works. The allowance of 10 pfennigs per barrel is out of all proportion to the harm done to the union by the manner in which the blast-furnace cement works undersell the union, and the position of the union is becoming so critical that the question of its dissolution calls for serious consideration.

Patent Office: Renumbering Specifications on Publication.—In order to give the public the advantage of having abridgments of specifications up to date while retaining their numerical sequence, applications for patents made subsequent to 1915 will be given new numbers when their complete specifications are accepted or become open to public inspection before acceptance. The new numbers will start with No. 100,001 (without any indication of date), and will supersede the original application numbers in all proceedings after acceptance of the complete specifications. It is intended in future to issue abridgments of specifications in the *Illustrated Official Journal* a few weeks later than that in which their acceptance or publication is advertised, so that they will be available for search purposes soon after the printed copies of the specifications are on sale; but, until the system is fully in force, they will only be issued when there are sufficient to make up a full sheet of sixteen pages. The present series of abridgments will run concurrently with the new series in the *Illustrated Official Journal* until April, 1917, when it will be entirely superseded.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

January 19. — Lawrence Chubb, "The Common Lands of London: the Story of their Preservation." Lord Farrer will preside.

January 26.—J. Arthur Hutton, Chairman of the British Cotton Growing Association, "The Effect of the War on Cotton Growing in the British Empire." Sir Daniel Morris, K.C.M.G., D.C.L., D.Sc., will preside.

February 2.—

February 9.—Professor J. A. Fleming, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

February 16.—The Hon. Lady Parsons, "Women's Work during and after the War."

February 23.—Miss H. B. Hanson, M.D., B.S., D.P.H., "Serbia as seen by a Red Cross Worker."

March 1.—Charles Delchevalerie, "Belgian Literature."

Indian Section.

January 13. — Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., late Survey of India, "The Romance of Indian Surveys." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

February 17.—C. A. Kincaid, C.V.O., Indian Civil Service (author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.), "The Saints of Pandharpur." Lieut.-Colonel Sir David W. K. Barr, K.C.S.I., will preside.

March 16.— Professor Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

Dates to be hereafter announced:—

R. W. Seton-Watson, D.Litt., "The Balkan Problem."

Charles R. Darling, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

Rev. P. H. Ditchfield, "The England of Shakespeare."

W. A. Craigie, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

Victor Horta, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

Professor T. G. Masaryk, "The Slavonic Peoples."

G. P. Baker, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

S. Charles Phillips, M.S.C.I., "Paper Supplies as affected by the War."

SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmyn, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

INDIAN SECTION.

Thursday afternoons at 4.30 p m.:—

April 6, May 18.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

February 1, March 7, May 2.

CANTOR LECTURES.

Monday afternoons at 4.30 p.m.:—

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m.:—

REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "National and Historic Buildings in the War Zone: their Beauty and their Ruin." Three Lectures.

February 7, 14, 21.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

JUVENILE LECTURE.

A lecture by Mr. James Swinburne, F.R.S., on "The Science of some Toys," will be given on Wednesday afternoon, January 12, at 3 p.m.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 10...Electrical Engineers, Institution of (Local Section), Mining Institute, Newcastle, 7.30 p.m. Mr. J. R. Beard, "The Design of High-Pressure Distribution Systems."

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Mr. R. M. Kearns, "Notes on Reinforced Concrete."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Sir A. Evans, "The Adriatic Slavs and their relation to the future Overland Route to Constantinople."

TUESDAY, JANUARY 11...Electrical Engineers, Institution of (Scottish Section), 207, Bath-street, Glasgow, 7.30 p.m. Professor M. Maclean and Mr. D. J. MacKellar, "Distribution and Rise of Temperature in Field Coils."

(Manchester Section.) 17, Albert-square, 7.30 p.m., Professor M. Walker, "The Predetermination of the Performance of Dynamo Electric Machinery."

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. S. Dow, "Some Principles in Industrial Lighting, with special reference to the Report of the Departmental Committee on Lighting in Factories and Workshops."

Asiatic Society, 22, Albemarle-street, W., 4 p.m. Mr. V. A. Smith, "Akbar, the Great Mogul, 1542-1605."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. F. W. Carter, "The Electric Locomotive."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Paper by Messrs. F. F. Renwick and Olaf Bloch.

Marine Engineers, Institute of, The Minories, Tower-hill, E., 7 p.m. Mr. J. H. Thompson, "Power-Driven Tools on Board Ship."

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Dr. V. Cornish, "The Strategic Geography of the War in relation to the British Empire."

WEDNESDAY, JANUARY 12...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. (Juvenile Lecture.) Mr. J. Swinburne, "The Science of some Toys."

Automobile Engineers, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. G. W. Watson, "Back Axles."

Electrical Engineers, Institution of (Yorkshire Section), Philosophical Hall, Leeds, 7 p.m. Mr. J. R. Beard, "The Design of High-Pressure Distribution Systems."

Japan Society, 20, Hanover-square, W., 3.30 p.m. Dr. Suzuki, "The Japanese Red Cross."

University of London, King's College, Strand, W.C., 5.15 p.m. Professor W. B. Bottomley, "The War and the Food Supply."

THURSDAY, JANUARY 13...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Colonel Sir Thomas H. Holdich, "The Romance of Indian Surveys."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Professor M. Walker, "The Predetermination of the Performance of Dynamo Electric Machinery."

FRIDAY, JANUARY 14...Malacological Society, Burlington House, W., 7 p.m. 1. Rev. A H. Cooke, "The Operculum of the genus *Bursa* (*Ranella*)." 2. Mr. E. A. Smith, "On the shells of the South African species of Sepiidæ." 3. Mr. A. Reynell, "On a volume of plates prepared by Rackett for the second edition of Pulteney's 'Dorsetshire Shells' in Hutchin's 'History of Dorset'; on Lovell Reeve's 'Elements of Conchology,' with some dates of publication."

Astronomical Society, Burlington House, 5 p.m.

Corrections.—Mr. W. W. Starmer asks that the following corrections be made in the report of his reply to questions asked after his paper on "Carillons and Chimes," reported on page 98 of the *Journal* of December 17th last:—

It was stated that there was a carillon at Liverpool. For the word "Liverpool" read "Loughborough."

In the sentence "He had heard it ['God save the King!'] played, and as the players had not the leading note in the right part of the scale they took it up several notes," for the words "several notes" read "a seventh."

In the sentence "If a bell had one series of harmonic terms," etc., for the word "terms" read "tones."

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FRIDAY, JANUARY 14, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 19th, 4.30 p.m. (Ordinary Meeting.) LAWRENCE CHUBB, "The Common Lands of London: the Story of their Preservation." LORD FARRER will preside.

Further particulars of the Society's meetings will be found at the end of this number.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

COVERS FOR JOURNALS.

For the convenience of Fellows wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s.* 6*d.* each, on application to the Secretary.

JUVENILE LECTURE.

On Wednesday afternoon, January 12th, Mr. James Swinburne, F.R.S., delivered the second Juvenile Lecture, the subject being "The Science of some Toys."

Mr. Swinburne said that the resolution of forces explained such toys as the kite and the sailing-boat in their elementary forms. This simple conception could then be applied to explain the main principles of the spinning-top and the more elaborate gyrostat. The gyrostat was used as a compass for steadying ships at sea, in the monorail, for steering torpedoes, and would probably be used eventually in aeroplanes. It had also been used for gunnery at sea. The earth might be regarded as a large gyrostat.

The bird-warbler showed the production of sound at varying pitch as the length of the little pipe altered. From this the propagation of sound might be considered, and how its velocity depended on the density and elasticity of the medium. The gramophone, used as a recording instrument, might be considered as analogous to the human ear, in something the same way as the camera resembled the eye. The sound coming in worked a diaphragm instead of a drumskin, and this worked a little lever which made a trace. For the real ear the drumskin worked little bones, which communicated the disturbances to the fibres of Corti. These fibres not only judged pitch, but they selected. In addition, they were affected by partial tones, so that the ear distinguished tone characteristics. These partials were due to each tone being made up as if of a simple tone with others superposed. The superposed tones were due to the instruments that produced them. So was the pitch. Organ pipes gave an extraordinary variety of tone characters, though there are only two kinds, flue and reed. The pitch depended on the velocity of sound and the length; the character on the mouthpiece and diameter in flue pipes, and the reed and tube in reed pipes. (Specimen pipes from an organ were sounded, varying from a tuba to a viole d'amour.)

A great deal had been written—at least in other countries—about the æsthetics of music, but without very much result. All ideas based on discussing the mental effects of chords one by one, or purely on the symmetry of form, as if music were like architecture, broke down in view of the effect of a gramophone run backwards. Music heard backwards sounded quite meaningless. But the chords and the symmetry were not altered.

On the motion of the Chairman a hearty vote of thanks was accorded to Mr. Swinburne for his interesting lecture, and the meeting terminated.

THE URALSK PROVINCE AND ITS OILFIELDS.*

In the last few years a good deal of interest has been aroused in an oil-bearing region which, it is widely believed, is destined to play an important part in supplying the future demands of the Russian Empire for petroleum and its products.

For some time past travellers and explorers have reported exudations of oil and gas, occurrences of asphalt, and other surface indications of petroleum, at various points in the tract known as the Kirghiz Steppes. These points have been located on maps, some fairly accurately, others far from correctly. This is partly due to the rarity, over a great part of the area, of landmarks of any kind, with regard to which the position of the observed occurrences may be described, and partly to the fact that the available maps of the region were not very accurate. In some parts of the steppe, the only possible points of reference are the tombs erected by the nomadic Kirghiz to their deceased saints, and a good deal of doubt seems to have existed about the correct naming of these places, adding to the difficulties of the explorers and cartographers.

Many of these localities have received more or less study from geologists and other experts, often by means of shallow pits and borings, since visible indications of the geological structure are as scanty as the landmarks. Various hypotheses as to the structure and the age of the beds have been advanced, in some cases backed by insufficient evidence or by no evidence at all, and, with the exception of a few areas which have been carefully investigated for commercial purposes, the geology of the region is little known as yet, whilst, owing to its great area, its wildness, and the sparseness of the population, it is probable that there are within its bounds indications of petroleum which have not yet been recorded. . . .

Roughly speaking, the reported signs of petroleum lie between the 51st and the 46th parallels of north latitude, and the 49th and 58th of east longitude. It will be seen that they are distributed over a very large part of the Uralsk Province. To get some sort of an idea of the extent of country involved, we may take a line from the point where the west boundary of the province reaches the Caspian shore, following this boundary northwards to the town of Alexandrovsk Gai, which lies just outside Uralsk, thence east to a point near the town of Temir, again south to Murtuk, and finally in a south-westerly direction, following more or less the course of the Emba River to the sea again, the southern boundary being, of course, the coast.

The area of this figure is, roughly speaking, some 60,000 square miles, somewhat greater than that of England and Wales. Evidences of oil are found all round outside these limits, and there is marked on this map a place called Djusa, in Turgai Province, which has attracted much attention of late, but, as we are considering the Uralsk Province particularly, we must draw the line somewhere.

In case these figures might lead astray persons of an enterprising and speculative disposition, let us emphasise the fact that we are not stating the dimensions of an oilfield, or of proven oil-bearing territory, but are merely noting that over this large area fairly frequent indications of petroleum occur.

Physical Features, Climate, etc.

The level of the Caspian Sea is 84 ft. below that of the Black Sea, and round its shores, also below sea-level, lies a zone of land, of greater or less width according to its inclination. By far the largest area of depression is that on the north, extending from the Volga to east of the Emba River, forming a belt of varying width. If a contour line be drawn, representing the datum line, ocean level, it will be seen that in general the part of this region north of lat. 50° is above, whilst that south of the lat. 50° is below it. In the eastern part of the area, however, where the ground rises more rapidly, this contour line turns sharply southwards.

Travelling inland from the shore of the Caspian Sea, a great plain is traversed, whose gentle rise northward is imperceptible. This same gentle inclination of the plain continues southwards into the sea for some miles. The coast-line is thus ill-defined, and consists of a belt of swampy land. Differences of level of a few feet in the surface of the sea cause the water to advance or retreat for a considerable distance. There are, it is true, no tides in the Caspian, but differences of level of four feet, and sometimes it is stated even of eight feet, are caused by the winds piling up the water in one direction or another, while other causes are differences of barometric pressure in the north and south ends of the Caspian, and also any conditions which disturb the equilibrium normally existing between loss by evaporation on the one hand, and the supply of water from rivers and rain on the other.

Returning to the land, the plain is, generally speaking, absolutely flat and featureless, every hollow having been filled and every prominence covered by the deposits of the Caspian Sea during the period, geologically very recent, during which it extended far beyond its present limits. The soil is formed of sandy clays, or clayey sands, often heavily charged with salt. In other places are encountered considerable accumulations of loose sand, due to the action of the wind. Other areas are swampy, while

* Extracted from a paper read by F. A. Holiday, A.R.C.Sc., F.G.S., M.A.I.M.E., before the Institution of Petroleum Technologists.

there are a number of salt lakes, many of which are dried up by the heat of summer, when their beds are covered with a glistening white deposit of salt.

Frequently one may travel for miles without ever meeting the smallest landmark of any kind, except here and there a tomb erected by the Kirghiz nomads.

Trees are entirely wanting on these steppes, excepting where they have been planted by the sides of rivers. Scanty grass and a small shrub are to be found over a great part of the area, on which the herds of the Kirghiz feed as they travel. In favoured spots, near streams and fresh water, there is greater abundance of herbage, whilst other places, where excess of salt or of loose sand renders vegetable life impossible, are quite desert.

Further northward and north-eastward, with increase of elevation the land becomes a plateau through which the rivers flow in deep gorges. The northern boundary of this tract of country is formed by the highlands near the Ural River, belonging to the Obscii Syrt. In the north-east and east, highlands rise gradually to the Mugodjar hills, and in the south-east corner the boundary is the elevated Ust-Urt plateau. On the west the plain stretches into the steppes of European Russia.

Thus in the east and north-east the highland is nearer the sea than in the west. The town of Uilsk is considerably higher than Uralsk, although the latter lies considerably to the north-west of it, and the general slope of the whole region appears to be from north-east down towards south-west.

The principal river in the Uralsk Province is, of course, the River Ural, which, rising in the Ural Mountains in Orenburg and travelling a little south of westward from the city of Orenburg to Uralsk, turns and flows practically due south to the Caspian Sea, into which it empties itself at Guriev.

Next in importance is the River Emba in the east, which rises near the Mugodjar hills, and, receiving as tributaries the Temir and some other unimportant streams, divides some fifty versts from the Caspian, the north or principal branch reaching the sea at the fishing village of Jila Cosa. It is a shallow river, and in some summers does not discharge directly into the sea, losing itself in swampy ground. Between the Ural and the Emba lie the rivers Uil and Sagiz, which have their sources in the highland to the north-east of the petroliferous area. The former disappears among the sands of Taisuekan and some small lakes near Kazil Kuga Bazar, and the latter in the lowlands near the Caspian to the north of Rakusha.

There are other unimportant rivers which all terminate in the same vague way.

West of Guriev, in the Cossack lands, a few small streams find their way into the Caspian, one in particular, the Bolshoi Baksa, which is really a branch of the Ural, passes the village of Novo-Bogatinsk, which is getting known as a probable oil-centre, and furnishes good water with fresh-water fishes as far as a dam near the village. Sometimes it runs dry, but water is obtained by making holes in its sandy bed. Below this dam it, as well as the other streams between it and Guriev, is apt to be brackish. Their degree of salinity, small at any time, is variable. When they are bringing down but little water they are invaded by the Caspian Sea. The Caspian waters, however, are only moderately saline, especially in the shallow northern parts, which are much influenced by the great volume of water discharged by the Volga and the Ural. Although the streams between Guriev and Novo-Bogatinsk are small, their importance is enhanced by the fact that they occur in a district promising to prove rich in oil.

As the climate of this region is quite continental, a considerable range of temperature is experienced in the course of the year, the summer and winter temperatures being respectively higher and lower than the mean temperature of its latitude for these seasons. . . .

There is thus a wide range of temperature, not only during the year, but also in the course of twenty-four hours, for often out on the steppes cold nights follow the hottest days in summer.

This region forms the north-western extremity of the great tract of low rainfall which stretches for some distance through Central Asia. At Guriev the rainfall is only some 17 cm. annually, but at Uralsk it is about 34 cm., the seasons of greatest rainfall at these two places being the spring and the summer respectively. In the Guriev district there is also a good deal of rain in the autumn.

There is a great deal of wind on the steppes, the prevailing winds coming from the north or north-east in winter, and the south and south-west in summer.

Taking it all round, however, the climate is not a bad one, and many Europeans live at Guriev and the adjoining centres in comparative comfort all the year round, with the exception, perhaps, of a few of the hottest days in the summer.

Navigation in the North Caspian and the Volga is closed by frost about the middle of November, to reopen in May.

Inhabitants, Towns, etc.

The Uralsk Province has a total area of about 125,000 square miles (284,400 square versts), and is about 3 per cent. larger than the British Isles. It is divided into two parts by the Ural River. All the land on the western side of the river, together with a narrow strip on the eastern side, is the territory of the Ural Cossacks; it amounts to some 27,250 square miles,

and is nearly as big as Scotland. The land on the east belongs to the Crown. The population of this great province was estimated a few years ago at about 750,000 souls, of whom nearly two-thirds were described as nomadic.

At this rate the "elbow-room" works out at about 106 acres per head of the population. Other estimates place the population rather higher, but it is impossible to get the correct figures for the wandering Kirghiz. The cattle of various kinds amounted at the same estimate to some 4,000,000, including horses, 370,000; camels, 188,000; oxen, 780,000; sheep, 2,470,000, etc. Occasional plagues make great havoc of the cattle.

The original inhabitants of this region are the Kirghiz, an essentially nomadic race, who travel with their herds of camels, horses, sheep and goats, which manage to subsist on the scanty grass covering the steppes.

These people live in dome-shaped tents, made of a light wooden frame covered with camel-skins or other suitable material, and having a circular hole at the top which can be closed if desired. The tents, which look very rough, are surprisingly comfortable, affording a considerable amount of shelter from the blazing sun as well as from the cold winds. The floor is partly covered with skins, rugs, and sometimes with beautiful Oriental carpets, but part of it is left bare, and on this the fire is made. The tents are easily erected and taken down, and with two or three trunks, containing a few simple household utensils, form the whole luggage of a Kirghiz family. The typical mode of transport is, of course, on the camel's back, but in these days many Kirghiz have carts.

Water is scarce in these steppes, but the Kirghiz have nevertheless discovered many spots where it may be had free, or nearly free, from salt, and here they have dug wells, which enable them to supply their needs when travelling. As the hot weather dries up the lower part of the steppe, they move northward to places where there is a better supply of water and pasture.

The entire absence of trees causes the fuel problem to be somewhat acute, and though, like the Arabs, they collect the dried manure of their herds for cooking and heating purposes, wood is greatly prized by them. The advent of Western civilisation furnished them with a certain amount of firewood in the shape of telegraph poles and the stakes used to mark out claims. They have, however, learnt by now to respect the former, though not, in most cases, the latter.

Far out in the steppes one meets with groups of Kirghiz who are still very primitive, but contact with the Russians has altered those who approach the inhabited districts. They earn money, or its equivalent in goods, by trade in cattle and fish, by transporting goods for the oil companies, and by manual labour, and thus raise their standard of living. Many of them settle in the villages, especially in the winter, though they mostly wander in summer.

As a race they are not particularly strong or energetic, but intelligent. Like many Asiatics they take kindly to study, and those that adopt the more settled life and attend schools, etc., make good pupils, but if they try to continue their higher education in Russian towns are liable to break down with pulmonary consumption, for they are essentially a nomadic, open-air race. Even in their native steppes they are frequently attacked by a terrible plague, which attacks the lungs, is exceedingly epidemic, and always rapidly fatal. The Cossacks and Europeans are not nearly so susceptible to this malady, although not altogether immune; but when the plague is about, the wandering groups of Kirghiz are not allowed to approach the towns, so that the white people are seldom attacked by it.

Regarded as workmen for the oilfields, the Kirghiz, although, as already said, somewhat lacking in strength and energy, are, on the other hand, sober and orderly. One is never sure of keeping a Kirghiz workman, as he generally has a family and some cattle wandering about somewhere, and is liable to go off and join them at short notice.

The ruling race in this country are, of course, the Ural Cossacks. They are a military race from their boyhood up, and have numerous privileges in return for their services. On their own lands the Cossacks have exclusive rights to all vegetable produce, and to all grazing, all game, and all fish, and no one else has the right to use the rivers in any way without their permission, and they are very jealous of their privileges. The Ural River is a great source of wealth to them. It is abundantly stocked with fish and great quantities of caviare are obtained, which forms a valuable export. In the fish-breeding season any sort of boating on the river is most strictly forbidden, and at one time this caused some difficulty to the oil companies at Guriev, who wanted to keep their communications open, across the Ural, with Dos-Sor and their other properties on the east side. At present there is a bridge on pontoons across the river.

The Cossacks are a sturdy race and capable of making good workmen; they are, however, as may be imagined, somewhat independent, and before the edict abolishing the vodka monopoly there was a great deal of insobriety in all the towns and villages.

The principal town of the whole region is Uralsk, with some 45,000 inhabitants; Cossacks and other Russians, Kirghiz and Tartars are all to be found there. There are many good buildings and fairly good hotel accommodation. The Governor of the Uralsk Province resides

there. All business connected with exploring and mining rights on the Cossack lands west of the River Ural must be conducted here with the Cossack authorities.

Along the Ural River between Uralsk and Guriev are a number of small towns, the chief being Lbishchensk (4,000 inhabitants) and Kalmikovsk (2,000 inhabitants).

Guriev, at the mouth of the Ural River, with 11,000 inhabitants, is the chief town after Uralsk. It has up to now served as the headquarters of the various companies operating in the oilfields. As long as the Volga and the north of the Caspian Sea are open to navigation, it may be reached from Astrakhan by sea. Astrakhan itself is reached from the interior of Russia, either by railroad or by the excellent steamers running on the Volga. The service between Astrakhan and Guriev is performed by two companies, the Eastern (Vostockki) and the Gurievski. The journey is accomplished under favourable conditions in thirty-six hours, though in bad weather, or if, as is often the case, heavy barges are towed behind the steamer, the voyage takes considerably longer. Up till two or three years ago the service was very bad, being performed by a couple of small boats, which, if the wind got rough, would put in to the shallows near the coast and anchor in a few feet of water, but lately there has been much improvement.

The landing at Guriev is somewhat difficult on account of the extreme shallowness of the water, especially when the wind blows the sea away from the shore. Travellers leave the steamer in a tug, which takes them as far as possible. The final stage of the journey is made in carts, which drive out to meet the tugs or barges, and take the passengers, sitting on their luggage, through the shallow water to the shore.

If navigation is not open on the Caspian, the journey to Guriev must be made *viâ* Uralsk, which itself is reached from the interior by rail, after crossing the Volga by ferry at Saratov. Guriev is then reached by the road, which nearly follows the course of the River Ural, with post-horses and carts (or tarantasses), or, if there is snow, with sledges. The distance by road is 330 miles, and there are twenty-three stations at the Cossack towns along the river, already referred to, at which horses are changed, sometimes with considerable delay. The journey is very uncomfortable, and its length depends on the ability of the traveller to endure the joltings and fatigue without resting. It is possible to travel night and day, as horses and drivers are continually changed, but four or five days are frequently taken over the journey. With a good automobile and with fairly dry weather this road may be covered in less than two days, the journey from Saratov to Guriev *viâ* Uralsk under these conditions being quicker than that *viâ* Astrakhan.

The steamboat companies are not recognised as mail carriers, and letters posted in Guriev for Astrakhan are taken by the postchaise right up to Uralsk or down again by rail to Astrakhan. This, the only route in winter, means great loss of time in summer.

In the spring of 1914 the Ural River overflowed its banks, and while part of the journey from Uralsk could be performed by road, crossing temporary lakes and streams on rafts, the lower country was completely flooded, and the last two days of the journey had to be performed in boats. As this inundation extended for some distance on either side of the river quite down to the sea, Guriev was an island for the time being. It should be pointed out that this state of things was altogether exceptional, nothing like it having been seen before by the living inhabitants of the country.

In the east of the province is the town of Temir, near the Orenburg-Tashkend Railway. It may be reached by road *viâ* Uilsk from Uralsk or Kalmikovsk. The roads are not made, but are only tracks across the steppe. On several of them there are small stations at which horses may be changed, but the accommodation on the others is inferior to that on the Uralsk-Guriev route.

Dos-Sor, at which there was no settlement a few years ago, now ranks as one of the towns of the province; there is, of course, no post-road there, but the oil companies provide a few water-stations between Dos-Sor and Guriev for their own traffic.

Besides the principal towns and villages, there are a few small settlements scattered about the steppe, some with a mixed population, and some inhabited by Kirghiz and Tartars only, with perhaps one Cossack as the representative of the Government.

Petroleum Mining Claims.

Prospecting or exploration claims are called zaiavkas. The word zaiavka means declaration or testimony, but is also used to denote a claim or plot of land.

This territory is attached to the Astrakhan mining district, and is under the jurisdiction of the Southern Mining Department at Novotcherkask.

The granting of zaiavkas for oil-prospecting is carried out by the Department of Agriculture and State Domains, whose headquarters are at Samara; claims on the Cossack lands west of the Ural River are granted at Uralsk.

The prospector must declare that he has placed claim-posts in such and such places, stating accurately their position with regard to some definite point of reference.

Each claim-post is the centre of a zaiavka, which has an area of 37½ desiatines, or about 101 acres, and forms a square whose sides measure 300 sagens, or about 700 yards. The certificate gives the right to explore the ground

in any manner, including drilling, for two years, before the end of which period allotments, or otvods, may be selected. Not more than 10 desiatines may be taken up in any one zaiavka, rather more than a quarter of the original prospecting claim; the remainder of the zaiavka reverts to the authorities, to deal with as they think fit.

When once an otvod is selected, the holders may keep it as long as they like, provided that they produce oil, on a yearly payment of Rs.20 per desiatine.

Zaiavka-holders cannot market any oil they may produce until they take out an otvod.

It is obvious that during the two years' tenure of a zaiavka every effort must be made to obtain a knowledge of the structure of the ground, in order to select the otvods in the best possible position. In places where geological data can be obtained from a superficial examination this may be comparatively easy, but unfortunately, over a great part of this region, such knowledge can only be obtained by digging pits or by trial drilling, which requires time and money.

In many cases the prospector who has staked out his claims in a hurry round a seepage (which is often the only indication of the underground conditions), in order to forestall possible rivals, is not the representative of a group who are in a position to carry out costly operations.

He, or his employers, may be obliged to look or capitalists or company promoters who will be in a position to develop the property. Much time may elapse, and there is a danger that, by the time the zaiavkas are in the hands of those willing and able to develop them, the two years' tenure is drawing to a close, and finally the otvods may have to be selected before sufficient evidence has been obtained.

There has, unfortunately, been a great deal of wild speculation in the Ural region during the last few years.

Thousands upon thousands of zaiavkas have been taken up, sometimes in places where there appears to be no possible reason for their selection. In many cases they have been hawked about, no exploratory work proceeding in the meantime, and their value gradually decreasing as the end of the two years' period drew nearer. An enormous amount of work has been thrown on the mining authorities, not only as regards the clerical labour involved in the granting of certificates, but also in the field, where their surveyors have had some difficulty in coping with their task. In some places trouble and confusion have occurred over the position of the claims, overlapping occurring, and this not necessarily through the deliberate "jumping" of claims.

For instance A, taking a certain Kirghiz tomb as his reference point, marks out a number of claims to the east of it. He then departs, and the Kirghiz promptly take his claim-posts for firewood. Soon afterwards B, starting from another tomb lying a few versts east of that of A, marks out claims to the west of it, and overlaps A's zaiavkas. Through inaccuracies in maps, or mistakes in naming, the tombs may be thought to be further apart than they really are, and A and B may meet later and compare plans, and honestly believe that they have not infringed on one another's rights. The geography of the country is getting better known now, but much confusion has arisen from these causes.

While much money has been wasted in rash speculation with zaiavkas on which never a stroke of work has been done, real hardship has been caused in other cases to genuine enterprises which have been nipped in the bud or held up by the outbreak of war, and it is to be hoped that when peace is restored the Russian authorities will deal with these cases in a liberal spirit.

Development.

Although special privileges to encourage the commercial exploration of this country were granted as early as 1899, its development has only been begun within the last few years.

Firstly, in 1899, exclusive rights to search for oil in six volosts (or districts) were granted to Lehmann and the heirs of Doppelmayer. These privileges were renewed several times until near the end of 1909. Several scientific men studied the field during this period, notably Messrs. Lebedev and Nikitin. Towards the end of the period Mr. Stahkoev joined the other capitalists. A good deal of exploration work was done, especially at Iskene, Dos-Sor, Karaton and Karatchungul. At Dos-Sor a number of wells were sunk by Messrs. Lehmann and Stahkeev, and some oil was obtained at moderate depths, but in the light of later work it is evident that none of these wells were deep enough to test the locality thoroughly—a mistake often made in prospecting. At Iskene oil was found, though not in large quantities, at various depths —75 ft., 170 ft., 190 ft., 490 ft.

At Karaton oil was encountered at various depths, a number of small shows being found at from 30 ft. to 60 ft., as well as at lower horizons. At Karatchungul several wells worthy of remark were drilled. In one in particular oil was struck at 143 ft., and spouted somewhat intermittently 90,000 poods in three days, and continued to flow at intervals, for some time giving, it is stated, some 300,000 poods. At this point gypsum was met with, followed by clay. But the most interesting point is that in another well, where oil was met at 37 ft. (200 poods a day) and at 126 ft. (130 poods a day), below the latter point a great thickness of gypsum and rock-salt was traversed, and at a depth of 1,000 ft., still in gypsum, evidences of petroleum were again encountered. Nevertheless, the commercial development of the

district was delayed. From the end of 1909 the concession was renewed until November 12th, 1912. An English company, the Ural-Caspian Oil Corporation, was formed, and took over all the privileges of the concession, to which two more volosts had been added (giving the territory the well-known form which appears on the maps), these privileges including a valuable rebate of half the excise duty on refined oils for the first eight million poods, this rebate holding good for five years from January, 1910. At five places, however, Dos-Sor, Iskene, Makat, Karaton, and Karatchungul, a certain number of zaiavkas were reserved by the original concessionaires, their plots and those of the Ural-Caspian Corporation alternating like the black and white squares on a chessboard. The new owners of the concession had to get to work and choose their zaiavkas before the end of 1912, and their surveyors and geologists had a busy time, and by the end of the period more than 11,000 zaiavkas had been selected.

Other companies subsequently acquiring territory within the area of the original concession were the Emba, Messrs. Nobels, the Emba-Caspian, the Kolchida of Baku, and others.

Up till now Dos-Sor has been the main centre of development. It was brought into prominence by well No. 3, of the Ural-Caspian Co., which on May 13th, 1911, from a depth of 732 ft., spouted with great violence; after one and a half days it caught fire and destroyed the derrick, but was finally arrested. It began to flow again in February, 1912, was closed down, and reopened in October, 1912, when in the first twenty-four hours it gave 120,000 poods (1,944 tons), and then settled down to 50,000 poods. Oil from it was received into an ambar (earth reservoir); but this broke down through flooding after heavy rain, and about 300,000 poods were lost. The well was then shut down till proper storage was built. This famous gusher is estimated to have produced in the early part of its history from 1½ to 2 million poods. It has since produced nearly 7 million poods. Last July it was stopped for cleaning and redrilling.

Since the Ural-Caspian No. 3 came in several other fountains have been struck at Dos-Sor by the same company, also by the Emba-Nobel, and more recently by the Emba-Caspian Co., and the production from this centre has steadily increased. It is still the only field from which oil has actually been exported. There are now some fifty-nine wells yielding oil: Ural-Caspian Co., thirty-two; Emba-Nobel, twenty-one; Emba-Caspian, six.

During 1912 Dos-Sor was connected by telegraph with Guriev. At the end of that year it was still a very small place, but a big building programme was then commencing. Pipe-lines were being laid both by the Ural-Caspian Co. and by Messrs. Nobels to the fishing village at Rakusha, at which point the oil is shipped and where refineries have been constructed.

Owing to the activities of the various companies mentioned above, the difference in Dos-Sor as seen late in 1912 and again in 1914 is startling, and it is now quite an important settlement with a population of over 2,000. The accommodation for the staffs and workmen is good and up to date, as are also the schools, religious establishments, sanatoria, and provisions for recreation. The chief difficulty as the place grows is to obtain a sufficient supply of good water. The administration of the different companies has been gradually moving from Guriev to Dos-Sor.

At Makat and Iskene a little drilling has been done since the concession was taken over in 1910, but without any important results. However, it was announced early this year that the Emba-Nobel Co. had a fountain at Makat. Preliminary work or trial drilling has been carried out also at Bli-ule, Bek-Beké, Iman Kara, Satep Aldi, and at other spots.

Drilling by the Canadian-Galician system was employed in the first place by the Ural-Caspian Co., but gradual modifications have been introduced by their engineers to suit the special requirements of the district. The Russian percussion system is also used by other firms. On account of the scarcity of water, oil-engines are largely employed.

The sudden outbreak of war in the summer of 1914 put a great check on the development of the Uralsk and of other oilfields. Capital immediately became scarce. A great deal of prospecting and preliminary work was necessarily stopped, and even the companies who were already well established had great difficulties to overcome. The loss of employees of every grade, difficulties regarding transport, the requisition of automobiles for Government service, all tended to disorganise their industry. All available resources were devoted to continuing the production from existing wells, drilling was confined to wells expected to produce shortly, while trial borings and new developments were to a great extent arrested.

The centres of development already referred to are in the "concession" area, and are being worked by the companies established there. Trial drilling and other exploratory work has been carried out, and in some cases is still proceeding, in spite of the war, by various firms at different places, some of them remote from Guriev and the Caspian Sea. It is impossible to get particulars of all of these; the operations are generally conducted with as little publicity as possible, and at the present time it is hard to get information from Russia. A few of them, however, are referred to here.

At Novo-Bogatinsk, on the Cossack lands, thirty-eight miles west of Guriev, exploration by deep drilling has been started lately by Messrs. Nobels and by the West Ural Co.

The former firm put down a well in 1912, finding some oil and a great deal of gas; this was followed by other trial wells with some success, but the exact results obtained were not made public.

In 1914 the West Ural Company drilled two deep wells by the rotary system. Finally, in August 6th, 1915, Messrs. Nobels struck a gusher, stated to have given an estimated yield of 300,000 poods in twenty-four hours. This is of considerable interest and importance, as the Cossack lands west of Guriev present somewhat of a geological puzzle, and differ a good deal from the Dos-Sor district. It is stated also that a Moscow firm, which has more recently started work in this district, has struck a small gusher.

At Tchernaia Rietchka, near Guriev, where surface indications of petroleum gas were observed some years ago, a little oil was found in some shallow boreholes near the tomb Kara Kis in 1913, and in 1914 Messrs. Nobels were drilling a trial well a little farther west.

At Maten Hoja (or Kuza), some eighty versts east of Kalmikovsk, Messrs. Nobels drilled a 300-ft. hole near a strong seepage of oil and gas in 1913, but got no result. In 1914 another well beginning with 16 in. diameter was started. A report referring to the striking of oil recently would appear to refer to this spot, or at least to this district, judging from the position described, although the name Maten Hoja is not used (this tomb, it may be remarked, is about three miles from the boring site selected last year, which might account for the name not being employed).

In the Novo-Kazanka district, Glininsky, the same firm are stated to have found good oil at small depths in several shallow borings.

At Djusa, just outside the Uralsk Province, in Turgai, a good oil of light specific gravity is said to have been obtained during 1914 at small depth.

At Murtuk, by the Temir River, oil is reported to have been struck.

Drilling was stated to be proceeding in the Karagandy Gorge by Messrs. Nobels, and at Kara Dzhidele by the South Eastern Petroleum Co. These spots are both in the Temir district.

Attention has also been turned of late, east of the Uralsk Province, to the Turgai.

Pipe-lines and Storage.

There are two 6-in. pipe-lines taking oil from Dos-Sor *viâ* Iskene, a distance of 45 miles, to Rakusha, the shipping port, where the refineries are situated. On account of the shallowness of the water, pipe-lines are laid on the sea bed and terminate at platforms six miles out, where the barges can moor. Of the two lines from Dos-Sor, one belongs to the Ural-Caspian Co., and is underground and embedded in cement; the other belongs to Messrs. Nobels, and is exposed. The first-mentioned line was at first provided with one pump, and could only handle 30,000 poods per diem. The addition of a second pump increased its capacity to 52,000 poods.

At Rakusha the Ural-Caspian Co. have tank storage for seven million poods, besides considerable tankage at Dos-Sor.

There is a trifling difference in the price of oil at Rakusha and that at Baku on account of the greater difficulty of shipping at the former place.

Refineries.

At Rakusha refineries have been erected by the Ural-Caspian Oil Co. and the Emba Co. The refining of oil in the district was undertaken in the first place with a view to getting the rebate of 50 per cent. of the excise duty on refined products, granted as one of the privileges of the concession.

When this condition ceases the question of refining oil at Rakusha will have to be considered entirely on its merits, and may possibly be discontinued.

As to the results obtained by refining, we may quote from a report of the Ural-Caspian Co. that in April–October, 1914, when the first trial distillations were made, a quantity of 6,789,122 poods gave—

	Poods.	Per cent.
Gasoline	24,830	0·36
Kerosene	1,607,366	23·66
Residues	5,094,009	74·92
Loss	71,917	1·06

The oil from the first gusher, No. 3 Ural-Caspian Co., was described as of specific gravity 0·861, greenish, and of good quality. The oil from another well, No. 10 of the same company, and coming from the same horizon as No. 3, was lighter, specific gravity 0·85, and, it is stated, could be used very well in lamps. From Karatchungul, oils of specific gravity 0·828, 0·858, and 0·853, and from Karaton of 0·867, have been obtained.

Seven samples of oil from the Guriev district are stated in Redwood and Eastlake's pocket-book to have specific gravities of 0·839, 0·869, 0·876, 0·880, 0·903, 0·904, and 0·908.

Production.

As already stated, up to the present time petroleum has been obtained in commercial quantities at Dos-Sor only.

During 1912 the production, only just beginning, is stated to have amounted to 1,017,000 poods. In 1913 the quantity was about 7,182,000 poods, and by the close of navigation in 1914 (statistics down to October, 1914) another 12,923,000 poods had been produced, making the total amount, from the beginning in 1912 to the close of shipping in 1914, some 21,122,000 poods, or 340,487 tons, of which it was estimated that the different companies produced in the following proportions:—

Ural-Caspian Oil Corporation	60·8 per cent.
Emba (Nobel)	38·0 ,,
Emba-Caspian	1·2 ,,

The above figures do not, of course, take into account the oil lost from the great gusher, estimated at 1½ to 2 million poods.

Comparison with other areas is somewhat premature, as the Uralsk-Emba fields are still in the infancy of their development, but, according to an estimate of the first nine months' production of the current year (1915), Dos-Sor produced some 13 million poods, which is just equal to the production for the same period in 1914 (first nine months) of Holy Island, Maikop, Tcheleken and Fergana combined (the joint production of these four oilfields was somewhat greater for 1915, 16 million poods, largely due to the Maikop gusher).

The production for the same period, January–September, 1915, of Russia was 426 million poods, of which 331 million came from Baku and the Apsheron peninsula. These figures are only approximate.

The rapid increase in production may be seen from the official figures of one company (the Ural-Caspian Oil Corporation). Beginning with the small production of 1912 there was—

In hand in April, 1913 .	1,128,000 poods.
April, 1913–April, 1914 (12 months)	5,658,430 ,,
April, 1914–November, 1914 (7 months)	6,056,868 ,,

while for the last twelve months (November, 1914–November, 1915) the production of this company was 10½ million poods, while their shipments in 1915 were about—

Kerosene	1,390,000 poods.
Crude	1,730,000 ,,
Residuals	7,441,000 ,,

It is estimated by the Ural-Caspian Oil Co. that their thirty-two producing wells, if allowed to yield without restriction (*i.e.*, if questions of transport, storage, labour, etc., did not impose any limits), are capable of producing from 350,000 to 400,000 poods weekly.

Occurrence of Petroleum.

The great plain which occupies all the central and western portions of this country is very barren of geological indications of any kind, the whole surface having been levelled and overlaid by the recent sediments of the Caspian Sea, a few isolated outcrops and the data obtained from pits and boreholes being the only evidences of structure available.

In the low-lying plain which occupies the southern and western parts of the petroliferous area, seepages occur at many points, the oil escaping from the reservoir beds and finding its way up through the Caspian sediments, spreading as it does so often in the neighbourhood of the "sors" or lakes which abound in the plain.

In some places "gas-holes," around which there is often a deposit of sulphur, are met with. Although not necessarily indications of petroleum, they appear generally to be associated with it in this region. Some of these spots are venerated by the Kirghiz, and are surrounded with little sticks with small pieces of cloth, etc., tied to them, the votive offerings of the pious.

The indications which first drew attention to the Dos-Sor, Iskene, Makat area were seepages of liquid oil rising through the sands. At Makat the reservoir beds are brought near the surface, and in shallow pits under a few feet of recent deposits beds with Lower Cretaceous fossils are exposed.

It is, however, in the higher lands to the east that the evidence as to the age of the oil-bearing beds is to be found. In some places they crop out on the sides or at the feet of hills, as at Iman-Kara, Kara-Murat, Alasha-Kazgan. In other places the exposure of the petroliferous strata is due to erosion by rivers.

The beds from which the oil issues, or which have deposits of "kir" (asphalt) at their outcrops, belong to the series of sands and clays already referred to as underlying the chalk. The most valuable data, gained through prolonged study of the district and of the well-records by their resident geologists, are of course the private property of the companies operating in the oilfields, and are not available. We may, however, safely conclude that the reservoir rocks in which the oil is stored under the Caspian sediments belong to the lower part of the Cretaceous (possibly also, in part, to the Jurassic). This, however, does not settle the question of the origin of the oil, the reservoir not being necessarily the bed in which the oil was formed.

The Permian is known to be petroliferous in Kazan, Samara, Simbirsk, Ufa and Orenburg, and may be the source of some if not of all the oil in the Ural-Emba district.

It has already been stated that some rocks generally considered as Permian have also been assigned to Tertiary and Post-Tertiary times. The gypsum of Karatchungul and that west of Guriev have both been the subject of some controversy, and will be briefly discussed here. At Lake Karatchungul, through the sands of the surrounding plain, rises an island of gypsum in which a hollow has been formed by solution of the rock. Under the Caspian sediments Cretaceous rocks are found, and the presumably Permian gypsum appears to rise through a cover of Cretaceous.

The view, however, has been advanced that the gypsum is recent, a deposit of the Caspian Sea, and that the Cretaceous has been brought near the surface in places by folding, the hollows in the Cretaceous being filled by gypsum. This idea appears to have been suggested by the finding of some recent shells in a deep borehole

n the gypsum. Such evidence, however, is not convincing. Shells from the overlying sediments may easily fall into a borehole, or, again, there may have been deep hollows in the gypsum formed by solution before the Caspian Sea covered the area. There exists such a hole to the west of Guriev, described by the inhabitants as a bottomless pit. In any case, it is difficult to conceive of beds of gypsum nearly 1,000 ft. thick being deposited by the Caspian Sea in recent times.

At Inder, near the east bank of the Ural River and about 150 versts north of Guriev, is a salt lake with gypsum cliffs on its northern shore. A broken chain of hills some 200 ft. high, 40 versts long, and 7–10 versts wide, with a general N.W.–S.E. trend, lies to the north of the lake. The north-western extremity of this range reaches the Ural River.

To the north of the lake the gypsum, with a conformably overlying sandstone, strikes N.E. and dips steeply to S.E., being in places turned over. Anticlinal structure is clearly observed in the gypsum.

On the west flank of the anticline a series of Jurassic beds lie unconformably, identified by fossils as Callovian and Portlandian. Following these, to the west are calcareous clays, and finally the white chalk. These beds, unlike the gypsum, have a north-westerly strike and a south-westerly dip. At the west of the range, at a place called Biele Rostosch, the white chalk is overlaid by beds assigned to the Aktchagil (Tertiary) series. The position of the gypsum here, relatively to the other beds, sufficiently indicates its pre-Jurassic age.

The same general strike of the gypsum is also observed to the east of Lake Inder to be N.N.E., with an easterly dip about 25°.

To the west of Guriev, between that town and the Tchernaia Rietchka, or Black River, several low anticlinal ridges of gypsum, yellow sandstone, and mudstone project through the Caspian deposits, striking N.N.E. A small island (Kameni Ostrov, or Stone Island) about 4 versts out in the Caspian Sea, showing the same material and strike, is a prolongation of these folds.

Going towards the tomb Kara Kis, which is on the Black River, 5½ miles west of Guriev, the gypsum is found in boreholes at successively lower levels, and at Kara Kis, where evidences of gas had been previously observed, small quantities of oil were found in 1913 in shallow boreholes above the gypsum. Further west the gypsum is lost sight of, but is found again by drilling at Novo-Bogatinsk, together with great thicknesses of salt.

The view has been advanced that to the west of Guriev the Caspian deposits are underlaid by a considerable thickness of Tertiary beds, and that the gypsum and salt beds here are much younger than those reached by drilling on the oilfields to the east (in the "concession" area). The similarity between the conditions of the gypsum west of Guriev, at Inder, are, however, sufficiently striking, and in the absence of further evidence it seems most reasonable to ascribe the gypsum of Tchernaia Rietchka and of Karatchungul, like that of Inder, to the Permian.

Transport.

All goods for Guriev and for the oilfields are landed at the Preestan or port, eight miles from Guriev. As already stated, the steamers cannot come to the shore, and the goods are either carted in from the tugs, or when the water is high enough (when the wind is not blowing off the shore) barges of light draught can be brought alongside the piers to discharge, and in this way heavy machinery can be got ashore.

Further transport is effected in carts drawn by horses or camels to Guriev, and then across the Ural River to the oilfields. This cartage of machinery, casing, provisions, etc., to the different centres has been a valuable source of employment for both Cossacks and Kirghiz. A number of automobiles are in use in this country now, but the older method of traction, though somewhat slow, is still the most reliable and economical for heavy goods.

Water Supply.

In Guriev each house has in its yard or outbuildings one or more large barrels or tanks for water storage. The water is brought to them by men who make a business of fetching it from the Ural River, into which they drive their water-carts, which consist of large, long barrels laid on their sides with square holes on the top (really on the upper "side") mounted on low carts. The scarcity of water in some parts of the steppe, already referred to, has caused much inconvenience at some of the centres of development, Dos-Sor, Iskene, Makat, etc. Water had to be carted from distant wells to these places—an expensive and inadequate method. The difficulty was to a certain extent overcome by the device of storing snow during the winter in long deep trenches, roofed over with non-conducting materials. Water is drawn from a sump at the end of the trench, and keeps quite cold even during the hottest summer.

The road from Guriev to Iskene, Dos-Sor and Makat is on a very dry part of the steppe, and several small stations have been erected, where water is stored for the use of the companies' employees, horses and camels on the road. The water has, of course, to be carted to these stations. There has been talk for some time of bringing water by pipes from the rivers to the oilfields, and there is no doubt that sooner or later something of the kind will have to be done. At present some automobiles are being used to bring water from the River Sagiz and other sources.

CHILEAN COAL.

By Josiah Harding, M.Inst.C.E.

(Translated by the author from an article on "El Carbon National" in *El Mercurio*, of Santiago, Chile, October 28th, 1915.)

From a series of interviews and articles recently published in the *Mercurio*, I see that this business is at last receiving the attention due to it. It is really very sad that a question of such transcendent importance has not before this been dealt with.

Commissioned by several firms and at different periods, I have had occasion to study some of the Chilean coal-fields, as also the best way of using the coal; so that I am in a position to contribute something to the study of this problem, which is of national interest.

Indications of coal are found in many parts of Chile, from Valparaiso to the Magellan Straits, but the fields which up to the present have shown great importance are those of the provinces of Concepcion and Arauco, and those of Valdivia and Magellan.

The most important Chilean coal-field is undoubtedly that of Arauco, which extends along the western foot of the Nahuelbuta range from Coronel (lat. 37° S.) to beyond Cañete (lat. 38° S.). The beds acquire their greatest thickness, purity, and uniformity in Cuyinco.

There is another coal-field opposite this along the coast from Huena Piden to Lebu, and between these two fields lies a great bed of fire-clay, of which I had a sample examined in England, and which proved quite suitable for pottery. This whole district will soon be crossed by the railways from Lebu to Sauces, and from Curanilahue to Los Alamos.

Regarding quality, I believe this coal may be classed as superior to that of Australia, and for many purposes better than some English coals. Although this coal can be used in ordinary furnaces and boilers, there are certain alterations which it is desirable to make where the permanent use of Chilean coal is contemplated.

As the result of experiments in locomotives, I was able to burn it without making *any* black smoke. To obtain this end it is necessary to admit part of the air required for combustion above the fire-bars and beneath a fire-brick arch. This is usually done through the fire-door with a baffle plate, but it is better to make two small openings in the front end of the fire-box immediately under the brick arch provided with doors by a lever from the foot-plate to adjust the air supply. The fire-bars should also be placed closer than for English coal, and a large combustion or flame space is also advisable. These arrangements are not indispensable, but conduce to economy and elimination of smoke.

Owing to the small quantity of tar contained, this coal lends itself admirably for making Mond gas, whether for boilers, furnaces, or gas-engines, in which service it will show a considerable economy over a steam-engine.

The coal obtained from the fields referred to could be shipped either at Coronel or Lebu, the latter being the most suitable port, although it would be necessary to expend a considerable sum to make Lebu available at all seasons. The companies who propose to exploit these coal-fields would do well to provide sufficient capital to include the cost of some colliers, as is done by the Lota and Coronel Company.

Regarding protection to the coal industry by means of an import duty on foreign coal, the conditions of the Chilean coast enable a duty to be levelled on all coal imported, from Caldera southward, leaving the northern ports free, and so avoiding an extra tax on the nitrate industry.

The fact that these great coal-fields have remained for so many years unworked would seem to indicate that the business requires State aid or protection in some way during the first few years. Coal-mining requires the inversion of large capital, with no prospect of returns during a few years, although afterwards the dividends are certain to be very good.

It is certainly worth while for the State to make some sacrifice, so that all or nearly all the coal now imported be replaced by a national product. Further, the quantity of coal that might be produced in the province of Arauco is so great that there would certainly be a surplus, which might be exported to the Argentine Republic. There is, in fact, a proposal to extend the Lebu-Sauces Railway across the Andes by the Pass of Lonquimay, placing these coal-fields in direct communication with the Argentine railways and with the port of Bahia Blanca.

TRADING WITH THE ENEMY.

The following communication has been issued by the Press Bureau :—

The Foreign Trade Department of the Foreign Office has been set up by the Foreign Office as a new Department in order to carry out the policy embodied in the Trading with the Enemy (Extension of Powers) Act, 1915. This Act gives power to prohibit trade by any person, firm, or company in the United Kingdom with any enemy persons or association established in neutral countries.

As the Foreign Trade Department will be concerned with preventing trade by British firms and companies with the enemy in neutral countries, it has been decided to merge with it the Trading with the Enemy Department of the Home Office, which has had the duty of enforcing the measures already taken to prevent trading with the enemy, and the staff of which will continue to perform the same duties as members of the new Department, in addition to taking part in the administration of the new Act.

Questions of contraband or the hindrance of oversea trade between neutrals and the enemy and the licensing of exports from this country,

and all questions of trading with the enemy other than those described above, will continue to be dealt with by the Government Departments which have hitherto been charged with these questions.

In order to secure the full benefit for British interests of the policy of the Department, the advice and assistance of business men will be invited through the Chambers of Commerce and other trade organisations. It is recognised that the success of this policy will depend upon the active co-operation of the business community. It is hoped, therefore, that business men will be willing to aid the Department, and also that they will not hesitate to consult it in any matter in which it can be of assistance to them.

Mr. L. Worthington Evans, M.P., has undertaken the direction of the new Department, with the title of Controller of the Foreign Trade Department of the Foreign Office. Offices have been obtained at Lancaster House, The Mall, S.W. (above the London Museum), which were opened on January 5th. All communications (including those relating to matters previously dealt with by the Trading with the Enemy Department of the Home Office) should be addressed to: The Controller of the Foreign Trade Department, Lancaster House, The Mall, London, S.W.

ARTS AND CRAFTS.

The Children's Room at the Victoria and Albert Museum.—It seems eminently fitting that the Victoria and Albert Museum should make special provision during war-time holidays for children, many of whom are rather at a loss for occupation this Christmas, and should try to interest them in the mass of interesting objects which the nation possesses. Certainly the small room given up to the youngsters at present cannot be said to suffer from lack of visitors, and they seem to enjoy themselves very thoroughly. On the other hand, when one turns to the objects on view, and considers the size of the children who are filling the room, one cannot but ask the question, "Why in the world is an exhibition of this type held at South Kensington?" It might with equal propriety and profit be held at Bethnal Green, or really at any of the local play centres. Undoubtedly the Victoria and Albert Museum does not attract as many visitors as it ought to do in virtue of the treasures which it contains and the attractive manner in which many of them are now displayed. There are many young people growing up who ought to know and use the galleries who are hardly conscious that they exist, and who, once they came to know them, would not only find them useful but would learn to derive much happiness from them. Still it must be remembered that the Victoria and Albert Museum is not, probably cannot be, a museum which makes so universal an appeal as a picture gallery, or such institutions as the Natural History Museum or the London Museum. In the first place, it takes rather more education to begin to appreciate what it contains. In the second, the main object of the collection is not a popular one. The museum was originally founded as a museum of industrial art. When the new building was opened the scheme of rearrangement was based in the main on the principle that the problem to be solved was the housing of the national treasures in such a way as would best fit them to serve this initial purpose. The historical interest was not altogether ignored, but its claims were rightly regarded as subservient to those of art and craftsmanship. Now an exhibition of this type does not and cannot make an appeal to the ordinary child of, say, eight or nine years of age. It is useless to encourage him by the provision of a solitary room filled largely with costume dolls and glorified dolls' houses and a few military objects. Directly he is outside its door he is lost in what is to him a wilderness, and if he is a child who has wandered in by himself and not a well-to-do boy brought by fond and anxious parents or friends, he tries to distract himself by meddling with the labels, playing with the handles of the furniture, and generally making himself a nuisance—and small blame to him. It is, of course, always difficult to see how a first experiment will work out, and all honour is due to the originators of the present scheme for having made a step in the right direction. For all that, it is to be hoped that, in the years to come, exhibitions intended for quite small children will be held elsewhere, and that a larger room may be set apart at South Kensington which will be intended primarily for young people of between twelve and fifteen who would be led on by what they see there to explore for themselves, with some chance of profit, the rest of the exhibition galleries. There are plenty of boys in the upper standards of the elementary schools who would thoroughly enjoy seeing, under a little guidance, just how a Japanese stencil is cut and what can be done with it, or how different people have treated hinges, or chair legs, or whatever it may be. There are still more boys and girls in our trade and technical schools who would learn more than can be told from an exhibition planned to meet their special needs. If they once came to look upon the Victoria and Albert Museum as the place where they really found what they wanted at that age, there would be a very good chance of their making use of it to good purpose in later life.

Art and Trade Schools and the War.—We are living in troublous times, and it is only natural that art should suffer from them rather more

than certain other branches of activity. Fifteen months ago it was mainly the artists and art workers who were feeling the pinch; to-day the changed circumstances are having an influence on the schools as well. A few of them are on the point of closing, many more are finding themselves hampered by the reduction of grants, whether from the local or the central authority, whilst the older male students either have enlisted or are occupied in some employment connected with the war. In the trade and technical schools the conditions are somewhat different, but even here the war has not been without its results—results which, though some of them are right and necessary, do not always seem to be either. For instance, whilst it seems perfectly legitimate for the local authorities to try to reduce their expenses and their staffs, one cannot help wondering on what principle, if any, the changes are carried out. In some departments, of course, the work is considerably less than it was, in others this seems the moment for pushing forward rather than for holding back. The working of all the organisations which deal with the higher education of boys is necessarily thrown out of gear, but this is not, or at any rate should not be, the case as regards the girls. It is surely more important now than ever it was to train girls thoroughly and efficiently to undertake skilled industrial work. Girls of fourteen to eighteen cannot be employed as nurses; it is undesirable to turn them into munition workers for the period of the war and then leave them to find what unskilled work they can for the rest of their lives. The more girls who can be trained now to take their places later on as intelligent skilled workwomen the better both for themselves and for the country at large. The strides which have been made in the general efficiency of the women's trade schools within the last few years was very well shown in the informal exhibition held at the Shoreditch school just before Christmas. It seemed, from the exhibits there, as though two of the main problems in education of this kind were on their way to being solved—the correlation of the artistic and technical side of the training, and the relation of the more literary education to them both. The work done in the "art room" was carried out on a very carefully and wisely-considered plan which led the students by gentle stages to grasp the main principles which lie at the root of elementary design, and the connection between the drawing and the practical work in embroidery, upholstery, etc., was wonderfully close. It was quite evident that there was no keeping the work in water-tight compartments, the two sides fitted into one another almost automatically. Again, the plan of teaching history to girls who are to be dressmakers, upholstresses and embroideresses in such a way that it not only lives to them, but is connected with their work, is one which bids fair to be productive of excellent results. Not only did the girls' books show the reasonableness of the scheme, but the attitude of the students (some of whom had been responsible for the simple copies of mediæval costume which were on view) showed how intelligent was the interest which this plan of study had awakened in them. An attempt to correlate the studies which, though necessarily rather different in scope, is similar in its aim, is bearing very good fruit at the School of Art Woodcarving, and it is to be hoped that in technical schools both for boys and girls this method of work will be increasingly adopted.

Christmas Cards.—This season has been hailed in some quarters as of importance as marking the first Christmas of all-British Christmas cards. There is a certain amount of obvious truth in the remark, of course, but as a matter of fact there were not a great number of German cards about last year, and there seems very little indication that the volume of British cards this year has been greater than usual. If it were not dangerous for anyone outside the trade to hazard a guess, one would be inclined to say it was probably less. Many people felt that their hearts were rather out of tune with the sending of "Merry Christmas" or even a more subdued greeting, and others were bent on economising. Such cards as there were, however, were on the whole very promising. They included, of course, a good many which had no pretensions to artistic value, but amongst those which aimed rather higher the standard of achievement was good. Some of the autograph cards with illuminated borders were designed in the right spirit of the olden days and introduced the Allied flags, the Gallic cock, the Russian eagle and other symbols of the Allies with varying success, it is true, but on the whole with a good deal of cleverness. There were a good many reproductions from the Old Masters, and one series in monochrome was very satisfactory. The more expensive and pretentious coloured pictures (though much better than such things would have been some years ago) were rather heavier in tint than they should have been, and a little inclined to be dingy rather than mellow. One inexpensive little card (brought out by a very well-known house) of the Botticelli at Milan was admirable in colour, and recalled the earlier coloured postcards of the same picture, which were a triumph of cheap colour work.

OBITUARY.

Thomas Robson Miller.—Mr. Thomas Robson Miller, who was elected a member of the Royal Society of Arts in 1889, died at his residence in Streatham on the 9th inst. in his eightieth year.

Mr. Miller was born at Heworth, Durham, in 1836. When twenty years old he entered the office of the North of England Steamship Insurance Club; a few years later he was appointed secretary of the club, and subsequently was also secretary of the North of England Steamship Protection Association. In 1886 he proceeded to London and became manager of the United Kingdom Mutual Steamship Insurance Association.

He took an important part in the establishment of the Shipping Federation in 1900, and was elected chairman of the Legal and Indemnity Committee, which office he vacated on being appointed chairman of the Finance Committee. He was for many years chairman of the Bureau Veritas, and of the Association of Average Adjusters for 1909. He was also for some time a member of the Council of the Chamber of Shipping and of its Parliamentary Committee.

GENERAL NOTES.

Opening the Yangtze Gorges. From a recent report by the United States Commercial Attaché in Pekin, it appears that the directors of a steamship company have petitioned the Chinese Government for a grant from the Szechwan Provincial Government to open certain gorges in the upper courses of the Yangtze River. The petitioners informed the Government that through their efforts some narrow and dangerous gorges in the Upper Yangtze have been opened, proving a boon to navigation in that part of the river; there still remain, however, four gorges to be opened. The estimated cost of the work is £40,000, of which the Governor of Szechwan has consented to raise £12,000. The petitioners requested that the other £28,000 be temporarily appropriated from the public funds of the Szechwan Provincial Government, to be refunded by the proceeds from a toll to be levied upon vessels passing that part of the river after the gorges are opened. The Ministry of the Interior has approved the plan of the petitioners' enterprise, but has decided that the question relating to the appropriation of funds for this work should be left in abeyance until the Ministry has obtained the views of the Governor of Szechwan.

Newspapers in Germany.—According to the *Paper Maker*, before the war there were about 6,000 newspapers and periodicals in Germany, and about 3,500 in Austria. Of these since the war some 1,100 of the German and 900 of the Austrian have ceased publication, while nearly 500 German newspapers have been compelled to raise their price owing to the dearness of paper, the generally increased cost of production, and the decrease in revenue from advertisements. Since the war nearly 7,000 books and pamphlets have appeared in Germany which come within the category of war literature, almost all being connected with propaganda.

The Wheat Crop in France, 1915.—According to the returns issued by the Minister of Agriculture, the wheat harvest in France for 1915 is estimated at 84,360,000 hectolitres (28,998,750 quarters), equivalent to 64,720,000 quintals (6,370,079 English tons). This shows an average yield of 14·82 hectolitres per hectare (16½ bushels per acre), which is below that of former years.

Output of Coal in the United Kingdom in 1914.—The total output of coal in the United Kingdom for the year 1914, according to the annual report of the Chief Inspector of Mines, amounted to 265,664,393 tons, and the value, £132,596,853, showing a decrease in the output of 21,766,080 tons, and in the value of £12,938,816, as compared with the figures for 1913. The average price of coal was 9*s.* 11·79*d.* per ton in 1914, as against 10*s.* 1·52*d.* in 1913. The quantity of coal exported (exclusive of coke and manufactured fuel and of coal shipped for the use of steamers engaged in foreign trade) was 59,039,880 tons. Of this, France received over 12¼ million tons, Italy over 8½ million, tons, Germany over 5¼ million tons, Sweden over 4¼ million tons, Russia over 3 million tons, Denmark over 3 million tons, Spain nearly 3 million tons, the Argentine over 2⅝ million tons, Egypt over 2½ million tons, Norway nearly 2½ million tons, and the Netherlands nearly 1⅞ million tons. The amount of coal remaining for home consumption was 184,670,503 tons, or 3·977 tons per head of the population. 36,289,010 tons were used in the manufacture of coke and briquettes, and 18,381,106 tons in the blast furnaces for the manufacture of pig iron, as against 39,560,489 tons and 21,223,607 tons respectively in 1913.

Direct Railway between Turin and Nice.—Since the outbreak of the war, the works on the French portion of the Nice and Cuneo Railway, with the exception of the piercing of the two principal tunnels—the Braus, 5,950 metres (3 miles 1,225 yards), and that of Mont Grazian, 3,880 metres (2 miles 722 yards) in length—have been at a standstill. At the former of these, the Braus, a junction of the two headings, driven from each side, was effected at the end of September. The boring machinery at both tunnels is driven by electricity.* It is stated, on good authority, that the works of this railway will shortly be resumed on the French side. In Italy the line is now open for traffic to within a mile of the frontier line at San Dalmazzo, the distance from Turin being 147 kilometres (91 miles). A branch, which will join the main line at Breil, 26 kilometres (16 miles) in length from Ventimiglia, most of which is in Italian territory, has already been opened to the public for about half the distance to the village of Airole.

* See *Journal*, Vol. LXIII. p. 60.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

JANUARY 19. — LAWRENCE CHUBB, "The Common Lands of London: the Story of their Preservation." LORD FARRER will preside.

JANUARY 26.—J. ARTHUR HUTTON, Chairman of the British Cotton Growing Association, "The Effect of the War on Cotton Growing in the British Empire." SIR DANIEL MORRIS, K.C.M.G., D.C.L., D.Sc., will preside.

FEBRUARY 2. — THE HON. LADY PARSONS, "Women's Work during and after the War."

FEBRUARY 9.—PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

FEBRUARY 16. — S. CHARLES PHILLIPS, M.S.C.I., "Paper Supplies as affected by the War."

FEBRUARY 23.—MISS H. B. HANSON, M.D., B.S., D.P.H., "Serbia as seen by a Red Cross Worker."

MARCH 1.—CHARLES DELCHEVALERIE, "Belgian Literature."

MARCH 8.—CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

INDIAN SECTION.

FEBRUARY 17.—C. A. KINCAID, C.V.O., Indian Civil Service (author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.), "The Saints of Pandharpur." LIEUT.-COLONEL SIR DAVID W. K. BARR, K.C.S.I., will preside.

MARCH 16.—PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

Dates to be hereafter announced:—

R. W. SETON-WATSON, D.Litt., "The Balkan Problem."

REV. P. H. DITCHFIELD, "The England of Shakespeare."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

VICTOR HORTA, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

PROFESSOR T. G. MASARYK, "The Slavonic Peoples."

G. P. BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

EDWARD PERCY STEBBING, F.L.S., F.R.G.S., Head of the Department of Forestry, University of Edinburgh, "Forestry and the War."

SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmyn, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

INDIAN SECTION.

Thursday afternoons at 4.30 p.m.:—

April 6, May 18.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

February 1, March 7, May 2.

CANTOR LECTURES.

Monday afternoons at 4.30 p.m.:—

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m.:—

REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "National and Historic Buildings in the War Zone: their Beauty and their Ruin." Three Lectures.

Syllabus.

LECTURE I.—FEBRUARY 7.—*Belgian Architecture and History.* Belgium a land of cities—What makes a city (Gen. xi. 4)—Tower—Church—Communal Hall—Belgian civil architecture, commercial—Cloth Halls before Town Halls—Churches borrowed, but splendid furniture given by Trade Guilds. Ypres typical — Tournai. Rhenish. Source of Noyon—Soissons. St. Remi—French efforts to annex Flanders—The Matins of Bruges—Battle of the Spurs. Courtrai—Rivalry of Ghent and Bruges—Edward III. and J. van Artevelde—Sluys—Coucy. Pierrefonds—Mediæval sieges—Philip van Artevelde, Roosebek. Suzerainty of Burgundy—Charles the Rash and Louis XI. Dinant—Sack of Liége. Mary of Burgundy.

Arras—Lierre. Charles V. and Philip II. Egmont and Horn—Louvain—Malines—Antwerp—Louis XIV. and William III. Namur. Bombardment of Brussels.

LECTURE II.—FEBRUARY 14.—*Gothic Architecture, French and English.* The French Cathedral, a Great Hall, the centre of the city's life. The English Cathedral a Monastic Missionary settlement, independent of the city. The problem of Mediæval Architecture, to reproduce Roman vaulting—Solved by permanent stone centrings (diagonal ribs) under the intersections of a groined vault (Vezelay, Durham, St. Denis, Sens). Buttresses necessary (Chartres, Amiens, Beauvais). The walls become screens of glass. Inside—Columns replaced by vaulting ribs running down to the ground (Notre Dame—N. D. de l'Épine Abbeville). Contrast of French and English plans (Notre Dame and Salisbury). In the English Cathedral, horizontal, not vertical perspective sought. Beauty of clustered columns. Purbeck causes deep mouldings. Multiplication of vaulting ribs. Lierne and fan vaulting—Flamboyant and perpendicular—English and French façades—The French Cathedral is the expression of the National ideal; the English, of the National history.

LECTURE III.—FEBRUARY 21.—*French Mediæval Sculpture.* Christian art that of a new-born society rising amidst a dying civilisation—Provençal sculpture, Arles, etc., decadent—Burgundian, full of life and imagination; but Classical influence traceable all through (Vezelay, Autun, Auxerre)—XIIth Century (Avallon, Bourges, N. and S. doors, Chartres, W. front). Elongation of statues, architectural not ignorant—Individual types, elaborate detail. The sculpture scheme of a XIIIth Century cathedral (Laon, Notre Dame, Amiens, Reims). The Judgment door (Autun, Notre Dame, Amiens, Rampillon, Reims, St. Maclou)—The Virgin's door—Local Saints and legends (St. John Baptist, Rouen; St. Stephen, St. Théophile, Paris; St. Thomas, Semur; St. Nicaise, Reims)—The Arts, Virtues and Vices—The Months and Daily Life (Paris, Amiens, Rouen)—Statuary (St. Stephen, Sens—The Virgin, Paris—Chartres, N. and S. porches)—Reims, W. portals—Figures of Christ (Chartres, Amiens, Reims, Troyes, Solesmes).

The lectures will be illustrated by lantern-slides.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 17...Victoria Institute, the Central Hall, Westminster, S.W., 4.30 p.m. Mr. E. J. Sewell, "The Principles Governing Bible Translation."

TUESDAY, JANUARY 18...Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m. Mr. T. T. S. de Jastrzebski, "The Register of Belgian Refugees."

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. H. Barringer, "Oil Storage."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "The Physiology of Anger and Fear." (Lecture I.)

Photographic Society, 35, Russell-square, W.C., 8 p.m. Mr. F. M. Duncan, "The Application of Photography to Biological Research."

WEDNESDAY, JANUARY 19...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. L. W. Chubb, "The Common Lands of London: the Story of their Preservation."

Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Professor A. H. Sayce, "The Land of Nod."

Meteorological Society, at the Surveyors' Institution, Great George-street, S.W., 7.30 p.m. Major H. G. Lyons, "Winter Climate of the Eastern Mediterranean."

Geological Society, Burlington House, W., 8 p.m.

Entomological Society, 11, Chandos-street, W., 8 p.m. Annual Meeting.

Literature, Royal Society of, 20, Hanover-square, W., 5.15 p.m. Professor Sir Henry Newbolt, "Georgian Poetry, 1912-1914."

University of London, King's College, W.C., 5.15 p.m. Dr. R. M. Burrows, "The War and the Near East."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.30 p.m.

THURSDAY, JANUARY 20...Geographical Society, Kensington-gore, 5 p.m. Mr. C. B. Fawcett, "The Middle Tees and its Tributaries."

Linnean Society, Burlington House, W., 5 p.m. 1. Mr. M. Christy, "On the Definition of 'Right' and 'Left' in relation to coiled, rolled, revolving, and similar objects: a Problem in Scientific Terminology." 2. Mr. H. W. Monckton, "Some Aspects of the Bagshot Sands Flora." 3. Mr. B. B. Woodward, "Colour-photographs of Mollusca."

Chemical Society, Burlington House, W., 8 p.m. 1. Mr. A. G. Perkin, "The colouring matter of cotton flowers." (Part III.) 2. Mr. A. H. Salway, "Studies on the oxidation of unsaturated fatty oils and unsaturated fatty acids. Part I.—The formation of acrolein by the oxidation of linseed oil and linolenic acid." 3. Messrs. S. G. Sastry and B. Ghosh, "Synthesis of keto-indo-pyranols." 4. Messrs. A. Marshall and G. Peace, "The vapour pressure of glyceryl trinitrate (nitroglycerine)."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. A. Bone, "The Utilisation of Energy from Coal: the Chemistry and Economics of Coal, and its By-Products." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m.

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Mr. H. H. Harrison, "The Principles of Modern Printing Telegraphy."

Historical Society, 22, Russell-square, W.C., 5 p.m. Mr. E. Lipson, "The Sources Available for the Study of Mediæval Economic History."

Numismatic Society, 22, Albemarle-street, W., 6 p.m.

FRIDAY, JANUARY 21...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor Sir James Dewar, "Problems in Capillarity."

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Captain T. B. Morley, "The Flow of Air through Nozzles."

SATURDAY, JANUARY 22...Royal Institution, Albemarle-street, W., 3 p.m. Mr. C. J. Holmes, "Raphael and Michaelangelo." (Lecture I.)

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FRIDAY, JANUARY 21, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

Wednesday, January 26th, 4.30 p.m. (Ordinary Meeting.) J. Arthur Hutton, Chairman of the British Cotton-Growing Association, "The Effect of the War on Cotton-Growing in the British Empire." Sir Daniel Morris, K.C.M.G., D.C.L., D.Sc., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

NORTH LONDON EXHIBITION TRUST.

In 1865 the Committee of the North London Working-classes and Industrial Exhibition (1864) presented to the Society of Arts a sum of £157, the balance of the surplus from that Exhibition, with a view to the annual award of prizes for the best specimens of skilled workmanship exhibited at the Art Workmanship Competitions of the Society of Arts. The Art Workmanship Competitions were discontinued after 1870, but since that date various prizes have been awarded under this Trust. Prizes were offered to the students of the Artistic Crafts Department of the Northampton Institute, Clerkenwell, in 1903, and have been continued annually to the present time. These have been awarded, for the present year, as follows:—

Senior Section.—Prize of £1 10*s*. and a Certificate to Emily May Bowler, for a hand-wrought Embroidery Cushion Cover.

Junior Section.—First Prize of £2 and a Certificate to Andrea Vecchione, for an Inlaid Mahogany Bureau.

Second Prizes of 15*s*. each and Certificates to Louis Chambers, for a set of Steel Dies and Impressions; and to William Lonsdale Collis, for a hand-wrought Ciborium and Silversmith's Drawings.

COVERS FOR JOURNALS.

For the convenience of Fellows wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s*. 6*d*. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, January 13th, 1916; Dr. Dugald Clerk, F.R.S., Chairman of the Council, in the chair.

The paper read was—

THE ROMANCE OF INDIAN SURVEYS.

By Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.

There would not appear to be much room for romance in the prosaic details of a highly technical profession dealing with mathematical deductions and land measurements. Nor does the actual process of bringing into action an assortment of admirably constructed instruments for the purpose of astronomical or terrestrial observations, and deducing therefrom by intricate calculations the shape of the earth and the exact space thereon which is occupied by any special part of it, lead to much romance.

It is not, therefore, with the contents of those elaborate volumes on the progress of the great triangulation of India, which, while they are records for all time of a magnificent work and a great success, are much too technical for light and popular reading, that we have to do to-day, so much as the early beginnings of surveys in the East—the first dawn of those adventurous excursions into the regions of scientific observation—rendered absolutely necessary by our growing Eastern expansion and the further necessity of defining its limits. There is another

aspect of Indian surveys, too, which is well worth a better record than it has yet received. Along with the solid and steady progress of a great scheme for the accurate mapping of the peninsula of India, and the attainment of a full knowledge of its vast resources and possibilities, there has ever been on the fringe of this internal work a tide of adventure, ebbing and flowing with the rise and fall of political interest in what lies beyond India, which has led to the ingathering of an enormous amount of geographical information—all bearing more or less on India and its destinies—and has resulted in a record of geographical enterprise unsurpassed by any such record in the world. Neither Spain, Portugal, nor Holland, the three great geographical nations of the past, can claim an equal position as peaceful world conquerors in the interests of science.

Now, I am very well aware that when we touch on the subject-matter of travellers' tales, we may find ourselves more deeply involved in the regions of romance than would be quite seemly if taken in connection with so dignified and important an institution as the Survey of India, but I feel sure that you will appreciate the fact that there are two widely different aspects of romance, and most of you will have learnt from experience that the romance of the truth often exceeds in interest that other romance which is born of the wild dreams of fancy. Sir Clements Markham, in his admirable *résumé* of Indian surveys,* has very justly observed that before you can survey a country you must first get there; and it was the getting there that started a whole series of maritime adventures, all of which added something to our preliminary geographical knowledge of the road to India, which commenced in the reign of Elizabeth and lasted until the more prosaic, scientific and certain methods of the Indian Marine service.

It was Captain Keeling who first visited Surat in 1607, and practically opened up the way to India, and it was Hawkins, who sailed with him as his second in command, who made that ever-memorable journey to the Court of the Great Mogul to enlist his favour and his sympathies for the English in their first commercial venture on the western coast of India. It was one of the most romantic episodes of the early exploitation of India, and the "plotts," or charts, which were gathered from the observations of Keeling, and of other adventurers who speedily followed in his tracks, resulted in the "Rules for Navigation," published by John Davis of Limehouse. Hakluyt, Archdeacon of Westminster, was the map-maker of this period. He worked on practical methods by collecting information from certain "noted seamen of Wapping." His researches and his invaluable contributions to the early geography of the East have only lately been duly recognised by a suitable memorial set up in Westminster Abbey; but we owe the Hakluyt Society to his memory, which, under the leadership of Sir Clements Markham, has for many years been giving to the public many of the most deeply interesting of travellers' tales of the past, which would otherwise have been lost or forgotten. About the time of his death, in 1616, the East India Company woke up to the value of their literary and geographical possessions, and Hakluyt's successor, the Rev. Sam Purchas, took official charge of the journals of East Indian voyages. His quaint and amusing style has rendered "Purchas his Pilgrimes" a rival in popularity to the "Pilgrim's Progress"; but whilst the latter is the finest allegory that ever was written, it can and must be conceded to Purchas that he is only occasionally apocryphal.

It is a matter for bitter regret to antiquarians that the gradual collection of the logs and journals of many ancient mariners finally outgrew the means for storing them in the East India Company's office. Many were irretrievably lost, and when the India Office came in for the heritage of the old Company's records in 1860, tons of literary material were turned out; and not only journals, but some of the most interesting of contemporary maps and charts have been missing ever since.

It was not until Rennell's days, in the latter half of the eighteenth century, that any attempt was made to produce a map of Hindustan from land surveys; but meanwhile the very necessary process of charting the coasts proceeded apace, and quite a number of useful young seamen made their names famous by their adventurous methods and successful work. Amongst them Wedgborough and Topping were most conspicuous. Topping became Chief Surveyor in Madras in 1794, and it would be exceedingly interesting to know of what his office and instrumental equipment consisted.

In 1800 the first efforts were made to chart the African coast of the Red Sea. Lord Valencia was the moving spirit in the expeditions (three of them) that were fitted out in India for the purpose, and he has left his name at Annesley

* I must acknowledge my indebtedness to this useful work for much of the information recorded in this paper.

Bay, the harbour from which the Abyssinian Expedition under Lord Napier started some seventy years later. A naval officer, Crawfurd, was sent up to the Abyssinian highlands to interview the Negus, and he left some geographical record of his expedition behind him; but, following his tracks during that memorable expedition in 1868, we found that he was forty miles wrong in his value for the latitude of Antalo. This must not be accepted as any criterion of the general usefulness of the geographical surveys of our predecessors in the last century, for I have long ago come to the conclusion that for keen continued power of observation and persistent attention to detail there were a good many of them that could give points to modern explorers. It was the instruments, not the men, which failed.

Between 1820 and 1830 the first surveys of the Persian Gulf were made. The naval headquarters was Bassidor, on the island of Kishm, one of the hottest naval bases in the world, and the duties of the Indian Navy were remarkably comprehensive. Surveying seems to have been carried on in the intervals of slave-trade suppression, pirate hunting, commerce extension, visiting chiefs with the object of maintaining the political *status quo*, and generally establishing British supremacy in the Gulf. Stories of wild adventure in the Persian Gulf have survived till this day. Not less remarkable was the venturesome survey of Mesopotamia. It would not be too much to say that never, since those first expeditions to the land of the Tigris and Euphrates, have conditions for continuous map-making been possible. Considering the importance of the geographical position of Mesopotamia, its wealth of historical association and its extraordinary capabilities, and the difficulties and dangers encountered during the twenty-six years of surveying which were carried on almost without interruption by officers of the Indian Service, this extraordinary work of map-making may well be regarded as an imperishable record for the old Indian Navy.

In 1837 Captain Lynch, who was second in command to Colonel Chesney during the original expedition which was to decide the future of railway communication with India, traversed the whole course of the Tigris from its source in Armenia to Bagdad. He then connected Nineveh, Bagdad, Babylon and Ctesiphon by triangulation. When he had done with the Tigris he set to work on the Euphrates, connecting the head of that river with the Mediterranean by chronometric measurements, and on his final retirement in 1843 was succeeded by his assistant, Felix Jones. Jones had seen service in the Red Sea Survey and about the coasts of India before joining the staff of Lynch. He boldly made his headquarters at Bagdad in command of the "Nitocris," and, although nearly single-handed and full of other duties than surveying, he carried his explorations into the country of the wild and dangerous tribes of Arabs. In 1844 he was with Rawlinson on the Persian frontier; he explored the ancient Nehrwán Canal system, surveyed the ancient bed of the Tigris, discovered the site of Opis, and exploited the Median wall; in 1852 he made a trigonometrical survey between the Tigris and the Upper Zab, fixing the position of Nineveh; and he completed an extraordinary survey career by making a plan of the city of Bagdad on a large scale. His work as a cartographer in actual mapping was excellent, but his Babylonian sheets were lost in the India Office. At the present time it is interesting to know our authority for the original mapping of Mesopotamia, which has, of course, been largely supplemented and extended since, but Felix Jones (who was finally appointed political resident at Bushire) owned the master hand which was responsible for the basis of all we now know.

The name of Lynch is historic in Mesopotamia. It is to the river steam service of Messrs. Lynch and Co. that we owe much of the success of our Mesopotamian Expedition. It is, indeed, only with the assistance of such a river service that our expedition has been possible. In 1832 the naval service, hitherto known as the Bombay Marine Service, became the Indian Navy, and its first admiral, Sir Charles Malcolm, inaugurated a period of activity in exploration and surveying which might almost be called the golden age of survey romance. He founded the Bombay Geographical Society, which at once conjures up a galaxy of famous names such as no geographical society in the world has equalled—Burton, Speke, Grant, Burnes, Wood, Pottinger, Rawlinson were just a few of them. They gathered in their comprehensive group explorers in all the corners of the Eastern world. A re-survey of the Red Sea became an urgent necessity. It was a dangerous and difficult service; not half of that sea was charted, and unknown and unsuspected risks attended every move.

Southern Arabia, East Africa, South-East Arabia afforded such splendid opportunities for pioneer work then as might well make the

mouths of modern geographers water! One of the most marvellous adventures was that of a midshipman—Midshipman Cruttenden—who walked into Arabia on his own responsibility and visited Dafur and Sanaa, whilst he exploited Yemen. It may be that less suspicion attached to the apparently irresponsible movements of explorers in those days. They were certainly received with less hostility, being regarded generally as interesting visitors who could have no ulterior motive in travelling in countries with which they were totally unfamiliar—slightly mad perhaps, but otherwise harmless. Certain it is that no European would dare now to set his foot as a casual tramp in many parts of Southern Arabia (in Hadramaut, for instance) where he could have moved with comparative freedom less than one hundred years ago.

As British rule extended itself gradually from the south and south-east of India across the peninsula to the north-west, it became abundantly clear that a thoroughly sound knowledge of approaches by the sea route should be fully and carefully acquired. Three hundred years B.C. a careful log had been kept of an Indian river expedition which started from about Attok, finally reaching the Persian Gulf. It had been kept by one Nearchos, the admiral of the fleet of the great Alexander; but a river like the Indus and a coast-line like that of Makran will change its contour and its channels in the course of a few years; wind and current will render them hardly recognisable; so the log of Nearchos was clearly out of date. The Arabs, too, when they carried out their successful invasion of the Indus valley by sea as well as by land, in the eighth century A.D., must have furnished themselves with some sort of a useful chart, for the Arabs were most able geographers and navigators, and by far the most scientific sailors of their time. Since then the channels of the Indus, as an open road to India, did not seem to have been fully explored, and a river survey was inaugurated which was full of remarkable incident and surprising results. The survey staff included Alexander Burnes and Lieut. John Wood, both of them names which will ever live in geographical history. Arrived at Attok, Burnes, accompanied by Wood, started on a mission to Kabul. A mission to Kabul in those days meant something very different from the political or military processions of later years Our surveyors and explorers of the last century had little to boast of in the way of picturesque accessories such as great retinues and important escorts. They usually found it advisable to do in Afghanistan as the Afghans do, to wear the dress of the country, and to cultivate its social manners. They talked the language like natives, and they passed for natives in a crowd. This expedition was one of the very earliest feelers out into the wild north-west that was ever projected, and we must remember that it did not start from Peshawar and our present frontier, but had to cross a wild stretch of what might, or might not, prove hostile country before reaching the Indus, should it make a start from India. From Attok, of course, which was well within the territory of the alien Sikh, a good deal of this risk was certainly discounted. At Kabul, Burnes and Wood separated. Burnes struck out to the north-west, across the Hindu Kush, to Afghan Turkistan and the Khanates beyond the Oxus, and he brought back with him a story of travel to Bokhara and Central Asia which created a geographical record and a great public sensation. Wood went north-east also to the Oxus with the express object of finding its source. A Lieut. Wyburd departed on a tour of exploration in Central Asia about the same time, and has never been heard of since. This was in 1835. Wood's adventures on his most astonishing journey to the Oxus are as romantic as the most earnest lover of romance could wish. "Wood's Oxus" is beginning to be rather a rare book; but it is a revelation of the difficulties and dangers of individual travel successfully overcome—difficulties and dangers which doubtless still exist (it would be a perilous journey even now), but which are in these days so largely discounted by our knowing all about them beforehand. It is to be noted that when political discussions were straightened out between Russia and ourselves by the determination of a boundary between Russia and Afghanistan in 1883, it was Wood's Lake (otherwise Lake Victoria) which was adopted as the eastern terminal point of the boundary (though it proved to be by no means terminal), and it was the position given by Burnes of his ferry across the Oxus which was to mark the point where the boundary was to follow the river. This, too, presented its difficulties to actual demarcation. The ferry no longer existed in 1883, and the post-house and buildings which once denoted its position had all been washed into the river. Shortly after there followed the war with Afghanistan. Transfrontier explorations were then discouraged by Government, and they have, in fact, remained discouraged ever since. What has been done in later years has been

done more or less reluctantly under the ægis of the Indian Government, and thus a good deal of the romance which clings to individual initiative and effort was knocked out of trans-frontier surveys. We must, however, remember that very much of our prestige in Asia is due to the insistent recognition of the sacredness of European life both on and beyond our borderland. The death of an Englishman amongst frontier tribespeople has to be instantly accounted for, or vengeance by force of arms must surely follow. In no other way can individual security be assured in a land where the murder of a European is one of the chief qualifications for Paradise on the part of the Mohammedan. Very rightly, therefore, does the Government of India discountenance irresponsible travellers who, employed on no mission of political importance, may involve a frontier expedition and much waste of life and money by their indiscretions in the persecution of their own fads or a search for notoriety. But this is a policy which cuts two ways. Whilst it does not imply any radical hostility to the attainment of geographical knowledge in the abstract, it very much curtails the possibilities of seizing on favourable opportunities for securing such knowledge, and it has had a most disheartening effect on the adventurous spirit of military officers, who would gladly follow the example of the geographical heroes of Bombay records, and arrive at a clear understanding of the wild uplands of the borderland which face them in the distance as they kick their heels in idleness along the Indian frontier. Thus for half a century or more we learnt nothing of the wild border hills fringing the great plateau of Afghanistan or Baluchistan, or of farther Kashmir, or the great Tibetan tableland—nothing, in short, of all that which from the military point of view it was most essential that we should know. When we contrast our inherent fear of "complications" arising from indiscreet exploration with the method actually pursued by Russia during the same period, or which would most certainly have been pursued by Germany had she been in our place, we begin to doubt whether that official policy of excessive caution was not misplaced. Indeed, when we started the last great Afghan war in 1878, we found it very much misplaced, for the loss of life entailed by want of topographical knowledge was sometimes deplorable.

It is time, however, to turn to the inauguration of the land surveys of India as apart from Indian naval records; for although the gradual development of so perfect a system of geodetic measurements and its application to the huge area of the peninsula of Hindustan has little in it during its century of steady progress that savours of romance, yet there are certain points in its history which appeal to the imagination, and of the many personal narratives which are hidden away in the immense series of volumes comprising Indian Survey reports there are some which deserve to be rescued from oblivion by reason of the romantic interest which surrounds them. Conceive the India of a century and a half ago, when roads were scarce and railways were not; when the gradual advance of British occupation by force of arms was just a fight maintained by masses of Indian troops trained on European principles and supported by small but valiant companies of Europeans; the land unredeemed from the vast area of forest which spread absolutely unbroken across the continent from sea to sea, wherein were peoples ranging in their degrees of development from the utter savages, or wild men, of Central India—a people who lived in trees and ate their food raw, splitting it to pieces with their nails—through the black and hairy (but intensely proud) community of the Bhils, and the cairn-erecting Stone Age tribes of Gonds, to the ornate and crafty Bengali, or the magnificent Afghan supporters of the Mogul Court.

It is true that, with the exception of the wild man, who has disappeared within the last fifty years, they are all there now; it is true that there are large spaces still in the Indian peninsula on which no white man ever sets his eyes; that there are most undoubtedly deep-shadowed, dark and remote regions within which the hideous rite of human sacrifice is not unknown (one of the last which was brought to light was performed in order to secure a favourable verdict in the Calcutta High Court); but these interesting relics of the past are rapidly disappearing in front of missionaries and deputy-commissioners; and India, with its hotels and its telephones, its motors and electricity, is becoming unromantic and prosaic. But there was romance in the days when the early researches commenced, and it has not been utterly wiped off the slate even yet.

Our earliest Indian surveyor-general, a man who has left behind him an imperishable name, was Rennell. Rennell served under Clive from 1763 to 1782, when he commenced a geographical career which lasted for fifty years. Rennell produced the first map of Hindustan, which was a compilation from route surveys and observations

taken with more or less care during the military expeditions and campaigns which were then incessant. That first map shows what a mass of information already existed before anything in the shape of exact geodetic triangulation was attempted. The maps from which the compilation was built up were very inaccurate, but the patchwork was pieced together with great skill, and Rennell seems to have considered that no more scientific method was really necessary. Surveying in the peninsula of India in those days was just as much of an adventure as it would be in Western China in our time.

The first really picturesque figure which appears in connection with Indian land surveys is that of Lambton. He was the originator of the Great Indian Survey. He gained a commission as officer of the 33rd Regiment, and he served under General Harris in the war with Tippu. Curiously enough, nothing is known of his origin. He never referred to it himself, but he is believed to have been a Durham man, and to have gained his first experiences in land-surveying in America. He was absolutely self-educated. After the fall of Seringapatam, when Lord Wellesley took measures for exploiting and exploring India, Lambton produced his scheme for the measurement of an arc of the meridian and for carrying triangulation across the peninsula from sea to sea. The measurement of an arc of the earth's surface was in those days of the very highest scientific importance, when we did not know the elements of the shape of the earth. Supported by Lord Wellesley, and approved by the Madras Government, Lambton set to work to collect instruments. A three-foot theodolite (*i.e.*, the diameter of the graduated horizontal plate was 3 ft.) was constructed by Cary. It was the first of its kind. It was the father of all the many theodolites that have followed in its Indian wake, and it fitly has closed its career by honourable retirement in a museum. But the start was inauspicious. It was captured by the French on its way to India, and it was only through the graceful courtesy of the French Governor of the Mauritius that it ever reached its destination.

Great was the difficulty in determining an absolute longitude in those days. Observations for its determination were taken at Madras during three different periods—commencing in 1787 and terminating in 1847—and the three results, which differ *inter se* by more than four minutes, have been adopted by the Indian Atlas, the Survey Department and the Admiralty respectively. Imagine the confusion! It lasted up to my time at the end of last century, and has only been finally adjusted by the telegraph. Now we really know where the Madras Observatory is.

This, however, did not interfere with the prosecution of Lambton's great work—the initial series of that magnificent scheme of geodetic triangulation which is dealt with in the ponderous volumes of the Indian reports. It was the temper and the scientific enthusiasm of the man which carried him through. The mere conveyance of so heavy an instrument to the tops of the hills selected as observing stations must have involved an army of carriers, and of jungle clearers. Here and there it was necessary to make use of pagodas, or high towers, and it was whilst being hauled up to the summit of the Tanjore pagoda that one of the guys carried away, and the instrument was dashed with great force against the side of the pagoda. The horizontal limb was distorted and the tangent screw and clamp were damaged. This would have disheartened most men; but we find Lambton shut up in his tent at Bangalore soon after the accident, straightening out the instrument with the assistance of one or two ordnance artificers by an ingenious contrivance of his own, and in six weeks he was back again in Tanjore working with the resuscitated instrument, which indeed had become the prop and mainstay of the Survey until 1830. His energy was unquenchable. At the end of the year 1818 Lambton was joined by a young assistant whose name has lived in Indian annals—Everest—and Everest describes his chief as "an old man with a bald head fringed with a few white hairs, about six feet high, well made and muscular. His complexion was fair, and his eyes, dimmed by long service, were blue. When he roused himself to adjust the great theodolite they shone with lustre, and his limbs moved with the vigour of full manhood." But this was nearly the last flicker of energy, and in June, 1819, he gave up triangulating. He had subjected his assistants recklessly to the same exposure in the worst jungles of India that he faced himself, and Everest had been invalided to the Cape. When he returned in 1822, he was only in time to see the last of his old chief, who died still working in harness on the road from Hyderabad to Nagpur. For many years Lambton received no sort of encouragement from the Government or from any scientific society. It was only when he was made a corresponding member of the French Institute

that the Royal Society conferred on him a fellowship. This was not till 1817.

From John Lambton's beginnings the gradual extension of a complete system of geodetic measurement of the whole vast area of the peninsula has been the work of nearly a century. It may be said to be complete now, but there is still the rounding-off of outlying regions to be considered, and the Great Trigonometrical Survey of India, with its immense record of geodetic investigations—unequalled by that of any other country, excepting perhaps Russia—is still alive. Possibly the word "*finis*" will be written at the end of the last volume of those records by the present Surveyor-General, Sir Sidney Burrard. This is the fundamental basis of all our map-making. It has given us the framework, or anatomy, of India, and on this framework an enormous series of maps, geographical, political, military, and cadastral, has been based. Whatever may be the destiny of India in the future, it must stand as an everlasting testimony to the scientific industry of the British nation. It can never be effaced so long as stone walls can contain the records. But whilst the prosecution of scientific work of this nature within the limits of the Indian peninsula, the painstaking record of infinite observations and the mathematical processes of their reduction at a headquarters office, does not lend itself much to romance, it does lay the foundations of other investigations which are not so strictly scientific, connected with the mapping of India and its borderlands, which may be full to the brim with weird experiences and extraordinary happenings. The ordinary humdrum business of land surveys progressing from year to year has been broken often enough by incidents which it is delightful to recall, and amongst them it is those generally which deal with the Himalayas that are the most striking.

At the beginning of the nineteenth century information about the Upper Himalayas was scanty and apocryphal. It was derived from Chinese sources through Jesuit missionaries, who had been busy in Tibet long before then. A map of Tibet had come into the hands of Father Regis, at Pekin, as early as the year 1711. The worthy father represented its inaccuracy to the Emperor Kanghi. The Emperor despatched two lamas who had been educated by the Jesuits at Pekin to make a better one. They were to visit Lhasa and the sources of the Ganges. In 1717 this map was published in Paris, and this was the source of our knowledge of Tibet and the course of the Sanpo (the Upper Brahmaputra) until the days of the native explorers of the Indian Survey. In 1796 the first surveying expedition into the Himalayas was organised, with the object of determining the source of the Ganges, and it was only in 1805 that the immense height of the Himalayan peaks in Nepal was appreciated; so that we may say that it was just about the beginning of the century that this land of romance beckoned to the explorer to follow some of its fascinating paths and to struggle to the attainment of its vast altitudes. Imagine the sensations of those early observers as they wandered slowly along the borders of the mighty Himalayan torrents through the narrow ways of the foothills, overwhelmed with the richness and the sweet oppression of sub-tropical vegetation, ever gaining something in altitude, till the hills on either side presented wider slopes of slippery grass festooned with flowers as in Kashmir, or else were blankly bare and prohibitive except where they touched the foot of the pine and rhododendron forests, skirting the rugged buttresses of the snow-capped heights. The dawning sensations of reaching to something infinitely high and mysterious is lost in these latter days in the dust and clatter of the tonga or of the mountain railway. But there was the real spirit of romance brooding over the chequered frost-bound and snow-patched peaks of Badrinath and Bandarpoonch then. The tales of Hindu mythology hung in festoons round the seats of the gods; the paradise of the Brahmans was up there, near the sky; all the beauty and the wealth of the mighty Indra were awaiting the pilgrim from the plains. From where the Ganges rushes out in cold torrents from the deep cavern of the Gaimukh it is but a day's stiff climb to the summit of the range intervening between the source of the Ganges and that of the Jumna; and from that range, within an amphitheatre of snow, decked with the beauty of white and purple rhododendron, you may see such a glory of snow landscape as you can find only in the Himalayas. You may find it again in Kashmir, in the Tragbal Pass, or in the eastern Himalayas near Darjeeling; but there is no other of the great mountain systems of the world—not the Alps (which between the Rhone and the Rhine could be dumped into one valley of the main Himalayas) or the Pyrenees, or the Andes—which can strike the imagination dumb with such a realisation of the spirit of romance as can the Himalayas.

It is in this region and beyond it, where the

rock barrier of the Himalayas merges into the plateau of Tibet or the transhimalayan uplands of Kashmir, that the most romantic episodes of the Indian Survey work have taken place, if we except the transfrontier of the western Indian borderland, the highlands of Afghanistan, and the flats of Baluchistan, with their fringe of wild mountains hedging the Indus border. Centuries ago the Himalayas were crossed by venturesome Chinese pilgrims in search of the truth as presented by Buddhism. There must have been thousands of them, and some few have told thrilling stories of stone-spitting dragons and other horrors which awaited them on their Himalayan travels. Still more centuries ago it was the gigantic geographical elbow, formed by the junction of the Himalayas and Hindu Kush, which witnessed all those amazing irruptions into India of Central Asian tribes, which were the prelude to the first recorded European invasion, viz., that of Alexander the Great. Persians, Assyrians, Medes and Parthians all had a look in before the Greeks came. They all pulled up at the Indus, and decided that the hot plains of India were not good for their constitutions. There is consequently a wealth of legend about these regions which it has been to the infinite interest of the Indian Survey officials to investigate and unravel, if by chance they could strike a balance between truth and pure fiction. Farther to the west they have struck the tracks of a great mediæval Arab commercial confederacy who, long after the Greeks, occupied the Indus valley and spread out their commercial enterprises till they had riddled all Asia with their tracks. And they, too, have left their records. So that there has been a substratum of tradition on which to found a series of ancient romances which might easily fill volumes had one the energy and wish to write them. It was the northern Himalayas and Tibet that offered the first field for pioneer research, both as a field for science and for adventure. Some of the most stirring incidents of survey investigations occurred during the prosaic progress of scientific observation. We can imagine the sensations of Everest, for instance, when he figured out in his computations that he must have been observing to the summit of the highest mountain in the world without knowing it. We can picture Bassevi with the spout of a boiling kettle near his mouth, inhaling steam to check the pneumonia which killed him, whilst recording the beats of a pendulum of a measured length to determine the effect of that gigantic upthrow of mountains on the force of gravity. We can imagine Tanner facing the full majesty of Nanga Parbat as it rose from the Indus to its summit when he found himself gazing up and down through 24,000 feet of mountain side. And nothing in its way more thrilling has been done than the passing of our Indian triangulation right through and over the Himalayas to a junction with the Russian surveys, so as to bring Petrograd into direct measurement with Calcutta. The story of it is a splendid record of dangers and difficulties overcome by steady, persistent, determined effort. But these not altogether ordinary incidents in the regular progress of work would probably give place in popular interest to the extraordinary achievements in the work of Asiatic exploration which have been accomplished by specially trained native agents. It is not easy to train the Asiatic to habits of close observation in unaccustomed fields. Heredity and instinct alike make him intensely conservative in habits of thought. He will not lift himself readily out of his environment, and, as a rule, the manners and mode of life, the idiosyncrasies of other peoples, are to him matter of profound indifference. I take it that this is, after all, the same everywhere amongst the untravelled communities of mankind. A narrow outlook means a narrow imagination, and it may be a mistake to suppose that the Asiatic, slow of speech to convey an impression, is not as capable of receiving those impressions as the average European. The Chinese pilgrims who tramped the weary way from Pekin to Lhasa and from Lhasa to Peshawar and Benares, and who now and then (about once in a century and perhaps one in a thousand) kept a rough descriptive log of their journeys, are only aroused to enthusiasm by the evidences of their faith which they find *en route*—the temples, the monasteries, the stupas and the sacred trees—and do not trouble to give any record of the nature of the scenery they passed through, or the people they met, though they may have much to say about the difficulties and risks of the road. Indeed, there is some very graphic writing about Himalayan tracks.

Mediæval Arab commercial travellers and geographers are much more instructive; but then they were probably the best educated and most enlightened travellers of their time. The Indian Survey began by enlisting the services of the best educated amongst those whose nationality and environment rendered them likely subjects for the work of exploring the

high tableland of Asia amongst people who were notoriously hostile to strangers. This was at first. Afterwards selections were made in every class of native society, especially from the military, where it was comparatively easy to judge the promise of ability and enterprise in the comparatively raw product before undertaking the long and expensive work of special education. At first, however, it was the village schoolmaster, the priest, and the travelling lama who offered the best material to work upon, and the results were certainly surprising. If there appeared to be a want of intelligent appreciation of the opportunity thus opened for gaining knowledge of the world and witnessing something of its wonders, there was no such want so far as the processes of route-surveying and the acquisition of simple geographical conceptions were concerned. That process of keeping a sordid record from hour to hour and day to day of the compass direction of the route to be followed from point to point, and the number of paces which were taken in the day's work, implied a concentration of thought on a monotonous and dull routine which would have maddened any imaginative European. Yet never a pace was missed nor a bearing wanting in a record of possibly years' duration, and the pilgrim, armed with a compass and a rosary to help him count his steps, with a false bottom to his box wherein was concealed a sextant to enable him to take simple observations for latitude when opportunity offered, would turn up at the end of a journey with a smiling face and a clean record. Even if he had the bad luck to fall on evil times, to be sold as a slave, or to be robbed and maltreated, his records, concealed in the lining of his coat, in his turban or his waistband, would usually be all there, and his keenness in the evolution of the resulting map work would be absolutely absorbing.

Stories of the astonishing exploits of these adventurers would fill a volume. It is true that they were slow to relate them. The details had often to be dragged out bit by bit. It was thus that the old Kumaon schoolmaster, Pundit Nain Sing, traversed Tibet for the first time from west to east. It was then that we learnt of the vast wealth of Tibet in gold, and that we were able to reduce the romances of the ancient Greeks (who dealt freely with such marvels as gold-digging ants amassing heaps of gold which were guarded by fierce dogs) to a more reasonable hypothesis, which proved once again that there was ever some distorted substratum of truth underlying the wildest tales of Ktesias and his kindred. It was then that the vast plateau region of Tibet was first opened out to the eyes of our imagination—the wide bare spaces of wind-swept upland, the frosted white-edged lakes of intense blue beneath the unclouded azure of the sky, the lines of pilgrims making their silent way to Lhasa, and the dreamland of that green valley of the Upper Brahmaputra with its monasteries, its temples, and its whitewashed towns. But it was that marvellous adventurer who figured as "A—K" in our lists who really first introduced us to Lhasa itself, long before the days of the Younghusband Mission. It was he who made the early plans of that weirdest of sacred cities of the East, and gave us a far-away look in at its temples and processions, its wealth of ancient relics, and the quaintness of its religious rites—strangest of which, perhaps, is the yearly selection of a scapegoat for the sins of the people, the wretch who throws dice with the mayor of the town for the privilege of having all the multitudinous sins and immoralities of the townsfolk shaken out of a yak's tail on to his head, and who always loses the throw. Finally he is thrown out of the community with many rites into the wilderness to die. Then there was the romance of the Brahmaputra. How did it get through that savage barrier of mountains to become the Brahmaputra of India? It was old man Kinthup who practically solved this problem; but I regret to say that years elapsed before the wise men of the East in political array would accept his story as anything better than fiction.

Kinthup was sold as a slave for years. He lost his instruments, but he never lost his way, and he exploited the wonderland of Eastern Tibet in spite of all misfortunes. His evidence as regards the Brahmaputra was considered conclusive by such Indian geographers as were best able to check his narrative. Thanks to the exploits of that splendid young traveller Captain Bailey, Kinthup now lives in honoured retirement with the halo of truthful adventure crowning his scanty grey hairs. His was a live romance.

On the western frontier no less than on the northern are there many thrilling tales which might be told of surprising happenings to those who have been despatched to complete the mapping of wide regions in Afghanistan which are even now only partially known. There was a man in my frontier survey party named Sheikh Mohiudin; he was a brilliant draftsman, a most determined explorer, with a thirst for

geographical information which I have never seen surpassed. But he was a man of ungoverned temper and frightfully rash. He plunged boldly into the deserts north of the Helmund River, and was found after many days dead of thirst with his small party around him. Only one escaped, and he had carried the unfinished map wound under his waistband and so preserved it from damage. He was picked up unconscious by a passing Afghan from the edge of the moist bed of a pool which had probably saved his life, and he was finally restored alive to his party, and through him was the fate of the others known. Indeed, that western frontier is the very home of romantic adventure still, but it is by no means usually connected with Indian Ordnance surveys.

I will conclude with a reference to one occasion on which my own feet trod very closely on the skirts of Greek romance, and which might almost be a story from dreamland. On the pretty flower-bordered Mall at Peshawar, looking northward from the cantonments over the city, the view is closed in by the dark line of frontier hills on the far side of the open plain. But at one point, just showing above the line there, whenever the prevailing frontier atmosphere of dust admits, are three knolls or peaks which might almost be mistaken for a part of the near ridges, but which are in reality many miles beyond them. They belong to the crest of a curved offshoot or spur running out eastward from the Kunar Hills into the Swat country, a comparatively small and isolated mountain system known as the Koh-i-Mor (the mountain of Mor). This is described by classical writers (notably by Arrian) as forming part of the country visited by Alexander the Great when he made his momentous march through the north-west of India. There is no great difficulty, now that we have complete geographical knowledge of all that lies between Kabul and the Indus north of the Khaibar route, in identifying generally, and step by step, the scenes of the Greek engagements with the fierce hill tribes of the north, some of whom are represented in these hills to-day. Place names have changed, but the rivers have held to their courses, and it is surprising how many of the old Greek names are to be recognised even now. I have never been able to ascend the Koh-i-Mor: so far as I know, no European officer has ever done so; but I have been on the neighbouring hills, and the character of the scenery and the vegetation is undoubtedly the same throughout this wild borderland. The wild vine and the ivy of classical reference trail over the rocks and festoon the broken sides of innumerable gullies in rank abundance, and from the wild vine a certain detestable wine is derived, which in these degenerate days would certainly not be worthy of Greek libations. On the southern slopes of the Koh-i-Mor there existed some fifty years ago, according to the early Indian Survey atlas sheets, a large scattered village called Nuzar, or Nusar. It has apparently disappeared—at least, I could find no really sound confirmation of the story of its existence under that name in 1894, although I made diligent inquiries in localities as near the mountain as I could get. I have no doubt, however, that it did exist, for it must have been here precisely that the historical incident occurred which describes Alexander as sparing the leading citizens of Nysa (or Nissa) because they claimed a Greek origin like his own. Some of you no doubt will remember the story. This was after he had been as far east as the Indus, where he fought the memorable fight of Aornos, when he returned westward to hunt the brother of Assakenos, who had taken refuge in the Chitral hills. These worthy citizens of Nysa claimed to be descended from the Greeks who in a dim and distant past had penetrated into the Indian borderland under one Dionysos. What they said was this: "The Nysæans entreat thee, oh king, for the reverence thou bearest to Dionysos their god, to leave the city untouched . . . for Bacchus . . . built this city for an habitation for such of his soldiers as age or accident have rendered unfit for military service. . . . He called the city Nysa (Νύσον) after the name of his nurse. . . . The mountain also, which is so near us, he would have denominated Meros (or the thigh), alluding to his birth from that of Jupiter." Now Arrian, who wrote Alexander's history 100 years later, says: "The city was built by Dionysos, or Bacchus, when he conquered the Indians, but who this Bacchus was, or at what time, or from whence, he conquered the Indians, is hard to determine." Arrian, on the whole, has proved to be a very passable and fairly accurate historian, and there can be little doubt that there were early irruptions into India from Greece long before the days of Alexander, and that this led to a fusion between the Pelasgic invaders and the natives of the country which was more definite and more systematic probably than that which must have occurred during the subsequent Greek occupation of Baktria and the Indus valley. Elsewhere we read of Bacchic festivals under the shadow of Meros, of wild

bands of dancing men and maidens clothed with leopard skins, their spears garlanded with ivy and their heads with the vine, on the green slopes of Meros — a truly delightful reminiscence of the romance of classical mythology to the heat-weary Anglo-Indian gazing at the ribs and ravines of the Koh-i-Mor. So far as Alexander is concerned, then, after sacrifice upon the mountain, the incident ends.

In the winter of 1894–95 I was at work within sight of the Koh-i-Mor, determining the position of a boundary which, amongst other purposes, should divide Kafiristan from Chitral. I had the luck to be able to penetrate some little distance into the country of these inscrutable people, the Kafirs, and to enjoy the opportunity of discussing some of their manners and customs with them. Amongst others was the custom of singing hymns and executing dances in honour of their war god, Gish, on the occasion of any specially successful raid into the territories of their Mohammedan neighbours. I obtained the words of their war hymn, and with the assistance of a Chitrali interpreter I got what I believe to be a fair translation of it. Imagine my surprise when it proved to be a veritable hymn to Bacchus, referring unmistakably to the origin of his birth from Meros, the "three-horned" hill, and appealing for further victories! It was not so very long ago that the Kafirs spread over the Koh-i-Mor to the confines of the Swat valley. They have ceased to do so, but they still cling with tenacity to the tradition that the mountain was once their own. And so we got to the back of the strange insistence of the Kafirs that they are of Greek origin—a tradition which for long years has been a puzzle to Indian administrators. It was an old tradition twenty-two centuries ago, when Alexander passed their way. There are certainly various little conventional habits amongst them which differentiate them from the Oriental, such as sitting on stools instead of squatting like the native; but there is no time to go into further details, nor is this the place for anthropological disquisition. It is but one out of many experiences which befall the Indian surveyor which carry him just for the time out of the routine world of scientific investigation and survey progress into realms which more closely border on real regions of romance.

DISCUSSION.

The Chairman (Dr. Dugald Clerk, F.R.S.), in opening the discussion, said the author had given a most interesting, and indeed a most romantic, address. He had shown very clearly the romance of surveying, the adventure and search into the unknown. Romance was not confined, however, even to such adventurous circumstances as those described by the author. Everyone felt the glory of the adventurer and the discoverer, but the romance of the knowledge of the earth, and of all the properties it contained, was necessarily dependent upon such work as the great triangulation to which Sir Thomas had alluded. Before any idea could be formed of the universe at large, it was necessary to know everything about the earth—its shape and its weight, and in that respect the romance of the subject had visited even London. The weight of the earth was first determined by Cavendish, about the beginning of the last century, in Bedford Square, by a rather rough instrument, and since Cavendish's determination English observers had worked hard at the subject. The final, and perhaps the most complete determination of the weight of the earth was made by Professor Boys, who had frequently lectured at the Royal Society of Arts. Boys's discovery of the quartz fibre made it possible to determine the weight of the earth with great accuracy, which, if it had not been for that discovery, would have been impossible. The early determinations of the weight of the earth were made with a silk fibre, a torsion balance, and large weights. The whole principle of the determination of the weight of the earth depended on the attraction between a small weight and a large weight, and determining from that the relative attraction of the earth, and for that purpose it was necessary to know the dimensions of the earth. Given the weight and dimensions of the earth, everything else could be calculated. Without that knowledge all that was known was the relative weight. Professor Poynting also determined the weight of the earth, and made the most romantic discovery that light had pressure. So that even in London there was a certain amount of romance. There was the romance of the discovery of the countless suns of the universe, the rate at which they came to the earth, and the general purpose, if any purpose at all could be traced, of that great universe, all depending and resting upon trigonometrical survey. Without that fundamental knowledge it was impossible to go any further. Romance existed all over the world. There was nothing more exciting, even to an inventor in designing a gas-engine, than to see for the first time some of his ideas actually at work.

Mr. Douglas W. Freshfield (President of the Royal Geographical Society) said it was always a pleasure to hear an address by an expert on his own subject, more particularly so when that subject was one in which the listener had taken much interest for many years. It was some forty years ago since he was first brought into connection with the direction of the Geographical Society, and since then he had been more or less in contact with officers of the Indian Survey. In one sense his object, as the Secretary of the Geographical

Society, had been to endeavour to procure the use of so many of the sheets of the Survey as could be communicated to the public, without political danger, for use by travellers in the first place, and for the construction of other maps on a small scale in the second place. In that task, which met at times with a certain amount of official obstruction, he received the very valuable support of the Commander-in-Chief in India at that time, Lord Roberts, and a great deal was done to enable the world at large to benefit from the splendid results of the Survey. Another sense in which he was brought into contact with the surveyors was when an International Commission was appointed to measure the glaciers all over the world. The heads of the Indian Survey, in the most generous manner, despite the immense amount of work they had to do, put the services of their officers at his disposal to establish marks in the upper valleys in order to show whether the glaciers of the Himalayas were in a period of retreat or advance. He had the pleasure of seeing the part of the Himalayas above Darjeeling fifteen years ago, and of making a journey round Kinchinjunga, and he then had as his companion and guide one of those wonderful men of whom the author had spoken, the native Pundits, who travelled and collected information in places where no European could go. He took the Pundit over a pass which he had never visited before, and when they arrived back in Calcutta the Pundit wrote him the most eloquent letter he had ever received, in which he expressed the hope that he would recommend him for official commendation and reward for having been through the "jaws of death and the gates of hell." That was his description of a very lofty but not too difficult snow pass. There was one name, Surat, mentioned at the beginning of the paper which suggested to him a pleasing recollection of an old traveller who he was afraid contributed nothing to surveying but a great deal to their amusement. It was at Surat that the Elizabethan traveller Coryat died, very picturesquely, from drinking too much sack on Christmas Day. Coryat was a wonderful man who walked all the way from Jerusalem to Delhi. He had been at the court of the Great Mogul and then went down to Surat to refresh himself before he started back for home through the Khanates. Some letters he wrote had a considerable interest; they were addressed to the Right Worshipful Fraternity of Sirenaical Gentlemen who met on the first Friday of every month at the sign of the Mermaid, and in one of them he sent his deep respects to Ben Jonson. There was one fact about him in which he had been rivalled by a more modern traveller, namely, that on his return to England he hung up his boots as a monument of his exploits. He thought those present would remember a living traveller who did the same thing, or, at any rate, whose boots were shown in Bond Street. He had much appreciated the author's eloquent description of the flowers and the scenery of the Himalayas, and entirely agreed with him, so far as his experience went, that there was no landscape in the world to be compared for combined beauty and sublimity with that which might be seen from the hills halfway between Darjeeling and Kinchinjunga. The Caucasus might, perhaps, have a more tender beauty, and certainly the Mountains of the Moon were weirder, but he thought the palm must be given to that portion of the Darjeeling Himalayas. No doubt at the other end of the range there was a still more wild and savage scenery, but the Karakoram did not possess the vegetation which gave the charm and contrast to the Eastern Himalayas.

Sir Henry Evan M. James, K.C.I.E., C.S.I., said that, like the previous speaker, he was deeply grateful to the author for his most unusually interesting paper. There was one point in regard to it which he desired to emphasise, because it was characteristic of the whole of the officers of the Indian Survey, namely, its modesty. The Indian Survey contained some of the most brilliant mathematicians and astronomers in the world, but they were never heard to blow their own trumpet. He remembered some twenty years ago seeing the present Surveyor-General, Sir Sidney Burrard, in a very remote corner of the Persian Gulf, "shooting stars at night," as he expressed it. He was then making observations to determine the longitude of India, and, although it was such an extraordinarily scientific operation, Sir Sidney was most kind in explaining it to him. He also had the pleasure of knowing Captain John Wood, of the Indian Navy, who, in the early 'thirties of the last century, made a memorable journey to the source of the Oxus. Captain Wood also was an extremely modest man; in his admirable book he hardly ever alluded to his own excellent trigonometrical work. He mentioned, just as an ordinary part of the day's work, during his first voyage up the Indus with Sir Alexander Burnes, his taking by triangulation the height of Takht-i-Suleiman, the greatest mountain in the border of the South Punjab. He also mentioned, quite as a matter of course, that when he advanced over the Pamirs in winter, with the thermometer thirty degrees below zero, he had taken the height above the sea of the great Victoria Lake, and also measured it scientifically. He believed it was a few hundred feet less than the height of Mont Blanc. Captain Wood was a very great man. The author, with his usual modesty, had mentioned none of his own feats. Personally, he happened to know of one, namely, that Sir Thomas had tracked the halts of Alexander's retreating army camp by camp, and if some day he would give a paper on that subject, he was sure the members would be very much pleased and enlightened.

Colonel C. E. Yate, C.S.I., C.M.G., M.P., said that all old Indians like himself were much indebted to the author for having so vividly put on record for the information of the world what the Indian Survey really was, all the hardships the surveyors had to

undergo, and the endurance they displayed. Many of them had given their lives in the prosecution of their duties. The old records of the surveyors were most interesting. Forty years ago he well remembered in wild places in Rajputana and Central India studying the reports of the topographical surveyors who had gone before him to many of those wild spots. The author had alluded to the valuable work that had been done in regard to the surveying of the Persian Gulf. Those services were of the utmost value at the present time, when all Britishers were hoping every moment to hear that General Aylmer had succeeded in linking up his forces with those of General Townshend. They all hoped to hear of the British troops triumphantly entering Bagdad before very long. In the campaign in Mesopotamia Indian troops as well as British had endured harder knocks, and had participated in heavier fighting, than had ever before fallen to their lot. He had no hesitation in saying that he looked forward to Mesopotamia being the prize of the Indian soldier, and he hoped to see canal colonies in the future along the Tigris and the Euphrates very much as they were along the Indus at the present moment. He agreed with all the author said about the work of the Indian surveyors, what splendid explorers they were, and what wonderful work they had done. He was glad to see how that wonderful old explorer, Kinthup, had been proved to be correct by Captain Bailey, and he welcomed the name of Bailey coming to the front again, because Bailey had been an honoured name in India for many years. He well remembered the case of the survey party mentioned by the author in connection with the survey of the deserts to the north of the Helmund River, in Seistan; how the last man of the party left alive was found unconscious with the unfinished map under his kamrbund, and that was a testimony to the faithfulness and devotion to duty of the Indian Survey through all their work.

Mr. W. Coldstream said the author was an able representative of the Indian Survey Department, who was well known for the versatility of his talents in various directions. He was skilled as an artist, and many who had resided at Simla would recollect the watercolour pictures which Sir Thomas from time to time contributed to the Fine Art Exhibition there. Artistic talent seemed to be a frequent endowment of the officers of the Indian Survey. Perhaps it was stimulated by the grand and beautiful scenery amid which their official duties constantly led them. However that might be, a majority of the best pictures in the Simla Fine Arts Exhibitions were contributed by officers of the Indian Survey. One remembered, for instance, the fine works of Tanner, Strahan, Bythell, and Sir Thomas himself; and in recent years Majors Gunter and Cowie, and the present Surveyor-General, Sir Sidney Burrard, were known as excellent artists. As a quondam Indian official, he could speak from experience of the great practical utility of the work done by the Indian Survey. It lay at the very foundation of many of the most important departments, such as those of Revenue and Forest.

Admiral the Hon. Sir Edmund R. Fremantle, G.C.B., in proposing a hearty vote of thanks to the author for his most interesting paper, said there was only one criticism he desired to make in regard to it, namely, that it contained so much about the work of other people and so little about the work of Sir Thomas himself. The author had, as everyone knew, rendered the very greatest services to the Indian Survey Department. Sir Thomas had referred to the surveying of the seas done by the old seamen who went out to India in the early days of the seventeenth century. All the work in that respect that had been done by naval men had been of great service to the commerce of the whole world. The author had referred to the fact that Mr. Lambton, who was apparently a man of very little education, had the great credit of founding the geodetical survey of India. It was a curious fact that one of the greatest surveyors in the Navy, Captain Cook, was also a self-educated man, but, nevertheless, both of those men had done extremely scientific work. Although Cook had very imperfect instruments he made exceedingly accurate surveys, and Lambton was evidently a man of the same type.

Major-General Beresford Lovett, C.B., C.S.I., in seconding the motion, said the story of the Indian Survey was almost unknown except amongst the Anglo-Indian communities, and the author's graphic description of the work that had been done was therefore all the more acceptable. He hoped the author would, on a future occasion, read another paper on his own personal adventures as a surveyor.

The resolution of thanks was then put and carried unanimously.

Colonel Sir Thomas Holdich, after thanking the Fellows for their kind vote of thanks, said he wished particularly to call attention to the very great part the Indian Navy had taken in clearing up the geographical problems connected with India. The Indian Navy had long since disappeared, but there was no reason why it should not receive the credit which was due to it for its work. He desired, in conclusion, to express the thanks of the meeting to Dr. Dugald Clerk for his kindness in taking the chair.

SIXTH ORDINARY MEETING.

Wednesday, January 19th, 1916; the Right Hon. Lord Farrer in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Aiken, Rev. James, M.A., St. Thomas' Manse, Georgetown, Demerara, British Guiana.

Briefer, Michael, Ausco Company Research Laboratory, Binghampton, New York, U.S.A.

Brooks, Edmund D., 89, Tenth-street South, Minneapolis, Minnesota, U.S.A.

Griggs, Professor Edward Howard, A.M., Montclair, New Jersey, U.S.A.

Hemmeter, John C., M.D., Ph.D., Sc.D., LL.D., 739, University Parkway (Roland Park), Baltimore, Maryland, U.S.A.

Howell, Hon. Clark, Atlanta, Georgia, U.S.A.

Lawrence, Thomas Richard, 5, Bellasis-road, Byculla, Bombay, India.

Monserrat, Nicholas D., Hartman Building, Columbus, Ohio, U.S.A.

Randolph Isham, D. E., 1827, Continental and Commercial National Bank Building, Chicago, Illinois, U.S.A.

Ridge, James A., The Ceylon Wharfage Co., Ltd., Colombo, Ceylon.

Sibert, General William L., Presidio, San Francisco, California, U.S.A.

Thorndike, Townsend William, M.D., 20, Newbury-street, Boston, Mass., U.S.A.

Updike, Daniel Berkeley, The Merrymount Press, 232, Summer-street, Boston, Mass., U.S.A.

The following candidate was balloted for and duly elected a Fellow of the Society :—

Bennett, John, 57, Telford-avenue, Streatham, S.W.

The Chairman, in introducing the lecturer, read the following letter which he had received from Lord Eversley, for many years the President of the Commons and Footpaths Preservation Society :—

Abbotsworthy House,
Kingsworthy, Winchester.
January 18th, 1916.

My dear Farrer,

I regret that I shall be unable to be present at the meeting of the Society of Arts to-morrow when Mr. Lawrence Chubb's paper on "Commons" will be read.

The infirmities of age have come upon me, and if present I should be unable to hear either the address or the discussion on it. I should have to content myself with the words *adsum qui feci*, which would be thought boastful.

I have not read Mr. Chubb's paper and am not responsible for it. Not the less, I am certain I should concur in it, for no one knows more of the subject than he does, and no one is more imbued with the principles which I have endeavoured to maintain during the fifty years of the movement.

My only fear, arising from the fact that Mr. Chubb has not submitted his paper to me, is that he may have been induced by his long association with me, to dwell too much on my own efforts and too little on those of others, many of them long ago dead, with whom it was my task and my pleasure to co-operate on the subject. I have warned him against this, I hope not in vain.

Yours very truly,
(Sd.) Eversley.

The paper read was—

THE COMMON LANDS OF LONDON: THE STORY OF THEIR PRESERVATION.

By Lawrence W. Chubb,
Secretary of the Commons and Footpaths Preservation Society.

Of all the many advantages enjoyed by the inhabitants of London, there are few, if any, more prized than the network of commons, parks, and other open spaces to be found in every quarter of the metropolis.

They are of practical value because of their utility as recreation grounds. They have perhaps an even greater value, because they bring to the doors of town-dwellers a message of Nature and a sense of quiet beauty and restfulness which have become essential in these days of strain and stress. Indeed, it is safe to assert that there are now few persons who cavil at the expenditure necessary for the acquisition and maintenance of open spaces, because it has come to be universally realised that a sufficiency of "open air lungs" is only less necessary to the citizen than adequate systems of sewerage and water-supply.

In view of the general recognition of the utility of commons as open spaces, it is somewhat remarkable that the demand for their protection should not have manifested itself until about fifty years ago. There had been slowly growing a latent feeling of hostility to the steady inroads upon commons in general, and metropolitan commons in particular. The feeling was only crystallised into action by the formation of the Commons and Footpaths Preservation Society. On July 19th, 1865, a meeting of gentlemen was held at the instance of Lord Eversley (then Mr. George Shaw Lefevre), at which it was decided to found the society. The necessary steps to organise the new body followed, and on January 24th, 1866, a meeting took place at the Mansion House, under the chairmanship of the Lord Mayor of London, at which the new society was publicly inaugurated. We therefore meet to-day within a week of the Jubilee of the public formation of the society.

Of its original founders the first chairman, Lord Eversley, now only remains, and the society has indeed been privileged in retaining his services, for it has been mainly due to Lord

Eversley's outstanding knowledge of the law of commons, and to his dogged pertinacity, wise judgment, and inspiring enthusiasm that the main objects of the society have been successfully accomplished.

The primary aim of the society was to put a stop to the constant encroachments which were taking place upon commons. Before inviting you to consider the extent and nature of these encroachments, it seems desirable to explain briefly that, in a strictly legal sense, a common is a tract of private land, the soil of which is vested in one person, generally the lord of the manor, but over which other persons, known as commoners, are entitled to exercise certain definite rights or customs. These rights are known as rights of common, and it is only while they remain that the land is a common. They generally include the right to turn out horses, cattle and sheep to graze upon the "wastes of the manor," as the commons are called. Often the commoners are also entitled to cut undergrowth for fuel, or for repairing their fences or houses, as well as bracken for litter, heather for thatching, and peat for fuel. While such rights are exercisable over the common, the lord of the manor cannot now lawfully take full advantage of his proprietary interests in the soil. The fight for commons is the story of the struggle of lords of manors to ignore these rights, or to evade by Parliamentary authority the consequence of their existence.

Greater London, as we shall see, is the happy possessor of about 15,900 acres of land which is still common, or which has been converted into public pleasure grounds by the purchase of the manorial and commoners' rights.

Large as this area is, it is but a small portion of the common lands which once existed in and about the metropolis. The Doomsday Survey gives us a glimpse of what London was like in the days of the Conqueror. It records, for instance, that at Westminster the village nestled round the minster, or church of St. Peter, which Edward the Confessor had built. It consisted of twenty-five houses of the abbot's immediate followers, nineteen homesteads of villeins, forty-two cottages with gardens, and a vineyard of four half-acres. There was sufficient common meadow by the riverside to make hay for a dozen plough teams, and to furnish pasture for the commoners' other cattle. Further around the village lay 1,000 acres of common fields or Lammas lands in acre strips, while on the land side were the open wastes and the common woods, where the swineherd found mast for the 200 pigs of the village. The Lammas lands were commonable, because, although the owners could grow crops upon them, they had to remain open to the pasturage of the commoners' cattle during the autumn and winter months from Old Lammas Day.

The conditions which existed at Westminster were repeated wherever the Saxon system of cultivation obtained a secure foothold. The manorial lords, implanted by the Normans, found that a great part of their manors consisted of common land, and that the commoners were by no means willing that this should be appropriated as the exclusive and private property of their lords. To overcome opposition on the part of the commoners, the barons, in Parliament assembled, passed in the year 1235 the Statute of Merton, an Act which has ever been responsible for bitterness and heart-burnings. It purported to allow the lord of the manor to enclose parts of the wastes of his manor, provided he left sufficient to supply the needs of the cattle of the freehold commoners. It completely ignored the ancient rights and customs of the humbler villeins, the copyholders and the inhabitants generally, and, in practice, it enabled an unscrupulous lord of a manor to disregard the wishes of the village, for the humble yeoman had little to hope for if he were hardy enough to challenge the desires of his manorial chief before judges who are alleged to have lent their aid to those who could afford to pay for it.

Vast areas of common land were appropriated under this injurious measure, and the outbursts of opposition which gave rise to the Tudor agrarian rebellions testified to the sense of iniquity engendered by the Statute of Merton.

Occasionally, however, the lord of the manor found it difficult to overcome the hostility of the commoners to large enclosures of waste lands, and early in the eighteenth century a new method was devised by which the objections of refractory opponents could be overridden. Moreover, in those parishes where the arable land consisted of common fields, held in separate acre and half-acre strips by a number of persons whose strips were hopelessly intermingled, it was seen that for the benefit of agriculture it was desirable to consolidate the individual holdings. The new method of procedure took the form of an application to Parliament for power to effect a partition of the commons in a particular parish or manor. The success of this method was speedily apparent. It provided a

satisfactory means of getting rid of common field cultivation. If it had stopped there little criticism would have been evoked. But speedily the scope of Inclosure Acts was extended to embrace ordinary commons as well. To such Acts strong objections have been raised. They deprived the small commoners of the power of effective local opposition. They could not make their voices heard before a Parliamentary Committee. Nevertheless, Inclosure Acts manifested a semblance of justice, since, upon the partition of a common, all persons legally interested as commoners, or otherwise, were entitled to receive an allotment of the land or other compensation in proportion to the value of their rights.

It is now, however, conceded by most modern historians that in their operation Inclosure Acts were often unjust and baneful to the small farmer and cottager. Such persons, upon the enclosure, received a trivial allotment situate some distance from their homes in lieu of their pasture and fuel rights. With the aid of the common those rights had enabled them to rear a few beasts when their own holdings were under crop. When deprived of the privilege of turning their stock to graze upon a large area of pastureland they were forced to abandon the rearing of animals, their holdings speedily became unprofitable with the extinction of this source of income, and their little properties gradually drifted into the hands of the large landowners. In this way the country lost its race of lesser yeoman farmers, and it is a significant fact that small-holdings are still to be found in any numbers only in proximity to spacious commons, such as the New Forest, or the Fells of the North, and the open hills of Wales. It is equally significant that the Small Holdings Act, 1907, contains a provision enabling County Councils to purchase land compulsorily for the purpose of re-creating common rights to be attached to small-holdings. It may be too late to restore the ancient system of small-holdings, but this modern recognition of the value of commons is an eloquent testimony to the loss sustained by the country when common lands disappeared.

Inclosure Acts speedily became the fashion, and the work of Parliament was congested by a multitude of applications for power to enclose commons. Between 1710 and 1869 no fewer than 4,719 Inclosure Acts were passed, and it is estimated that, by their means, over 5,000,000 acres of common lands were divided.

The counties bordering upon London felt the full effects of the new movement, as the following table will show:—

County.	No. of Acts.	Estimated area enclosed.
		acres.
Middlesex . . .	42	53,615
Essex	67	40,015
Herts	61	61,436
Surrey	80	56,915
Kent	31	7,743
	281	219,724

Included in this total were Acts for enclosing the commons of St. Leonard, Shoreditch, Willesden, Chiswick, Finchley, Edgware, Hornsey, Newington Butts, St. George's, Southwark, Lambeth, Penge, Dulwich, and Croydon. Indeed, more than four times as much common land was enclosed within London proper as the land which has since been bought and dedicated to the public use and enjoyment, and it has often been necessary to buy back as open spaces at building value land which was formerly common. In one instance, that of Hainault Forest, the enclosure of 4,000 acres of magnificent and primeval woodland was authorised in 1851. Owing to the growth of East London, it was, in 1903, found necessary by Mr. Edward North Buxton to formulate and carry through a scheme for buying back 798 acres of this land for the public at the price of £22,430. It had cost no less than £42,000 to grub up the timber in the forest. The London County Council is now replanting part of this area.

From about the year 1860 there gradually arose a movement in opposition to the passage of Inclosure Acts. It had come to be recognised that in and about towns it was imperatively necessary that the health, recreation and comfort of the inhabitants should receive consideration, and that, from the point of view of amenity, commons in their natural state were a real and permanent asset to the community. Moreover, means were sought to restrain the steady influx into cities of agricultural labourers from rural districts. This it was at last realised was in no small degree due to the loss of the commons. No regard had been paid under Inclosure Acts to the interests of the poor, and the lot of the labourer had gone from bad to worse. Added to this, was the knowledge that the preamble of each Inclosure Act which declared

that land was required for the growth of corn was often a farce. This was proved by the fact that no effort was made to cultivate tens of thousands of acres of land which had been enclosed. Indeed, to this day there are tracts of land within twenty miles of London the enclosure of which was decreed seventy years ago in order that corn might be grown, but which have never even been fenced.

For such reasons public opinion slowly formed against the passage of further Inclosure Acts. The first step in the direction of organised opposition was taken in 1865. In that year a proposal was submitted to Parliament for dealing with Wimbledon Common, one of the finest and most spacious commons in the neighbourhood of London.

The lord of the manor, the then Lord Spencer, actuated no doubt by the worthiest motives, propounded a scheme involving the sale of Putney Heath, which formed one-third of the common. The money received from the sale was to be devoted to extinguishing the rights of the commoners and to improving the remaining 680 acres, with a view to dedicating the land as a park.

The lord of the manor proposed to reserve to himself the right to erect a mansion in the park thus formed, and with the part proceeds of the sale of gravel and of outlying portions of the common a rent-charge was to be paid to Lord Spencer, equal to the average of his past receipts from gravel and otherwise.

Judged by the standard of Inclosure Acts, the proposed provision for the public needs was most generous. But the commoners and residents of the neighbourhood naturally resented the sacrifice of over 300 acres of the common and the conversion of the residue into a fenced park.

A local committee, presided over by Sir Henry Peek, was formed to oppose the scheme, and its efforts were stimulated by the appointment, on February 21st, 1865, of a Select Committee "to inquire into the best means of preserving for the public use the Forests, Commons, and Open Spaces in and around the Metropolis."

Of this committee Lord Eversley was fortunately a member. The Wimbledon Common scheme received its consideration, and it heard evidence asserting that the public had no legal rights whatever to the use or enjoyment of the common, and that the commoners were so few in number and importance as to impose no effective barrier between the lord of the manor and his scheme. The committee, of which the late Sir Henry Doulton was chairman, rejected such propositions and promptly reported:—

"That it is not expedient that the Wimbledon Common should be fenced round or inclosed, or that the existing common rights should be extinguished;

"That it is not necessary, and would be undesirable, that any part of the common should be sold;

"That the 20 Hen. 3, c. 4, commonly called the Statute of Merton, by which a Lord of the Manor can inclose without either the assent of the Commoners or the sanction of Parliament, ought immediately to be repealed."

In consequence of these views, the Wimbledon Bill failed to receive the assent of Parliament, and as will shortly be shown the common was afterwards preserved in its entirety.

The Select Committee now extended their inquiries, and later on, in the year 1865, presented a second and lengthy report accompanied by voluminous evidence with regard to metropolitan commons. This report, which is the foundation of the Commons Preservation movement, was drawn up by Lord Eversley and Mr. Philip H. Lawrence, the first honorary solicitor to the Commons Preservation Society, was approved by the chairman and was adopted by a large majority of the committee.

The report enunciated the broad and important principle that "there is no Open Space within fifteen miles of London which can be spared, or which should be reduced in area." It urged that a scheme put forward by the Metropolitan Board of Works for buying up the interests of the lords of manors and commoners at an estimated outlay of £6,000,000 was unwise and unnecessary, since the committee were of the opinion that existing rights of common were sufficient to safeguard the public against enclosure.

As an alternative to the partition of commons, the report recommended that such lands should be regulated or placed under the management of public authorities without prejudice to the legal interests involved. It reiterated in stronger terms its first conclusion that the Statute of Merton should be dealt with on the ground that "the necessity of providing Open Spaces for health and recreation has become paramount to the mere improvement of those lands in an agricultural sense, and seeing that the inevitable result of the inclosure by private individuals of lands in the populous suburbs of the metropolis would be not even agricultural improvement, but building, they

have no hesitation in coming to the conclusion that it is time the Statute of Merton should be repealed."

The need for action had indeed become urgent Finding that Parliament was not disposed to pass further Inclosure Bills for commons around London, many lords of manors had reverted to the older method of enclosure by means of approvement under the Statute of Merton, which had fallen into desuetude in favour of the easier method of partition by Inclosure Act. In every direction commons were being ruthlessly absorbed. Epping Forest was fast disappearing; Berkhamsted Common was bisected; Hampstead Heath was gravely threatened, and such invaluable open spaces as Tooting and Plumstead Commons and Bostall Heath were already enclosed.

It was to combat this wholesale attack that the Commons Society was founded, and those who desire a detailed and fascinating account of the many fights which ensued should consult "Commons, Forests and Footpaths," the work of Lord Eversley, whose unique knowledge of every case places him in a pre-eminent position as an authority, and would justify him in claiming, should he so desire, the title of historian of the movement. I have made frequent use of Lord Eversley's book for the purposes of this paper.

The first tangible outcome of the formation of the Society was the passage of the Metropolitan Commons Act, 1866, which forbade the enclosure of commons within the Metropolitan Police District, and which set up the regulating machinery recommended by the Select Committee in 1865. This Act has already led to the permanent protection of no less an area than 4,171 acres of commons in and around London.

Because of their dramatic interest, however, the many bitter contests waged against enclosures under the Statute of Merton naturally appeal most to the imagination.

Hampstead Heath formed the subject of the first fight. The Heath is perhaps the best-beloved of the numerous open spaces situate within easy reach of the City. It is the traditional Mecca of the poor upon Bank Holidays. Acting as a barrier between the steady march of bricks and mortar and the green fields, it commands fine views over the smoke banks of London as well as over the rustic part of Middlesex, and its sylvan setting renders it a delight alike to the artist and lover of natural beauty.

The Heath was a common within the manor of Sir Thomas Maryon Wilson, and for many years that gentleman had made repeated but, happily, fruitless attempts to induce Parliament to allow him to deal with it as part of his building estate. Before the Select Committee of 1865 Sir Thomas "asserted his absolute interest in the land, free from any common or other rights, and his intention to make what use of it he could by leasing it for building purposes," complaining that by the outcry raised against him he had been deprived of £50,000 a year.

True to his threat, Sir Thomas commenced to build houses upon the most conspicuous parts of the Heath. His action was promptly challenged by Mr. Gurney Hoare, who brought a suit against Sir Thomas on behalf of the commoners of the class to which Mr. Hoare belonged. Lord Romilly, the Master of the Rolls, overruled technical objections taken to the form of the legal proceedings, and established the society's claim that a single commoner might take proceedings on behalf of all representatives of his class. The issues of fact involved in the suit were directed to be tried by a jury. Before this could be done Sir Thomas died. His successor manifested a different disposition, and announced that he did not intend to proceed with the buildings upon the Heath. An arrangement was reached by which the Metropolitan Board of Works bought out the manorial rights for £45,000. Before the suit originally commenced, Sir Thomas Maryon Wilson had demanded no less a sum than £400,000 for the Heath. The outcome of the expensive legal proceedings thus fully repaid Mr. Hoare, his friends, and the Commons Society for embarking upon litigation.

The Heath then extended to 268 acres. It was increased in 1889 by the addition of Parliament Hill Fields, purchased for the sum of £300,000 after five years' strenuous exertion. In 1898 it was further enriched by the addition of Golders Hill, and in 1907 the Heath was raised to its present area—667 acres—by the acquisition of 80 acres of land around which the new Hampstead suburb is being built under the watchful care of Mrs. Barnett. It is to be hoped that, at some future time, the frontages of Ken Wood may also be added to Hampstead Heath, for they are indispensable to the full enjoyment of this magnificent open space.

Berkhamsted Common is not, strictly speaking, a metropolitan common, for it lies twenty-five miles away from the city. But no account of the movement would be complete without a

reference to the costly and successful suit which led to the protection of this elevated and beautiful tract of land. It has an area of about 1,150 acres, and was formerly in an estate of the Duchy of Cornwall. In 1862 this estate was sold by the Duchy to the trustees of the late Lord Brownlow, who at once endeavoured to secure the sole control of the common. As a first step the trustees induced the villagers to agree to the diversion of a broad grass drive which traversed it from south to north. Then gravel pits were dug in such a position as to stop another drive, and several small enclosures were effected as a tentative measure.

Some of the commoners objected to the enclosures, and the trustees promptly sought to meet their objections by purchasing their rights. The common, however, had been largely resorted to by the inhabitants of Berkhamsted, who had cut fern and gorse, not in respect of ancient tenements but as inhabitants. As a concession to these persons the trustees proposed to present a recreation ground of forty-three acres to the town, subject to the condition that the common should be freed from all rights of common within six months. Forty-four of the freeholders and copyholders were induced to fall in with this scheme, and the trustees felt themselves sufficiently secure to proceed with an enclosure upon a great scale. Accordingly, in February, 1866, the agent of the estate erected high iron fences in two lines across the common, enclosing 434 acres and leaving two completely detached portions at each end. The fences effectively stopped passage over the common, and obviously were designed to facilitate the appropriation of the entire open space.

In the *Times* newspaper, Lord Brownlow's solicitors asserted that "the public has no more right to pass over the common than a stranger has to pass through a commoner's private garden, and that even a copyholder tenant of the manor, entitled to common rights, can only go upon the common in order to place his sheep there, and to look after them when there, and, therefore, with that qualification, any person who drives, rides, or walks across the common out of the public highway is a trespasser."

This arbitrary attitude was promptly challenged, for amongst the commoners was Mr. Augustus Smith, whose life's work in the Scilly Islands had marked him out as a man of strong character and great courage. Lord Eversley, acting on behalf of the society, was able to induce Mr. Smith to champion the cause of the commoners.

It was decided to abate the enclosure by the forcible removal of the fences. The story of this removal cannot be better told than in Lord Eversley's own words:—

"It was arranged with a contractor in London to send down at night to Berkhamsted a force of 120 navvies, for the purpose of pulling down the iron fences in as short a time as possible. On March 6th, 1866, a special train left Euston, shortly after midnight, with the requisite number of labourers, skilled workmen and gangers, armed with proper implements and crowbars. At this point the operation nearly miscarried. The contractor, it appeared, had sub-let his contract to another person. The two met together at a public-house near Euston Station the evening before the intended raid and drank so freely that neither of them was in a condition to lead the force into action, and the navvies arrived at Tring without a leader, and with no instructions. Fortunately, Mr. Lawrence (the society's solicitor) had sent a confidential clerk to watch the proceedings from a distance, and this gentleman, perceiving the difficulty, took the lead of the force.

"A procession was formed at the station. A march of three miles in the moonlight brought them to Berkhamsted Common, and the object of the expedition was then first made known to the rank-and-file. The men were told off in detachments of a dozen strong. The substantial joints of the railings were then loosened by hammers and chisels, and the crowbars did the rest. Before six a.m. the whole of the fences, two miles in length, were levelled to the ground, and the railings were laid in heaps with as little damage as possible. It was seven o'clock before the alarm was given, and when Lord Brownlow's agent appeared on the scene he found that Berkhamsted Common was no longer enclosed. It was too late to do more than make an energetic protest against the alleged trespass.

"Meanwhile the news spread, and the inhabitants of the district flocked to the scene. Gentlemen came in their carriages and dog-carts; shopkeepers from Berkhamsted and farmers in their gigs; labourers on foot tested the reality of what they saw by wandering over the common, and cutting morsels of the flowering gorse, to prove, as they said, that the land was their own again. Thus were the 430 acres restored to the common, and two miles of iron fences removed."

Proceedings were forthwith commenced against Mr. Smith, who brought a cross suit in the Chancery Division against the Brownlow

Trustees, claiming on behalf of himself and the other commoners that their rights should be ascertained, and that the lord of the manor should be restrained from interfering with them or from enclosing the common. For four long years the suit dragged on, and finally, in 1870, Lord Romilly, who tried the case, gave judgment on all points in favour of Mr. Smith. Thus by Mr. Smith's splendid action, fought under the guidance of the Commons Society, this beautiful stretch of down and woodland was saved from extinction as an open space, to form a lasting monument to one whose purse and sympathy were ever at the disposal of worthy public causes.

Following close upon the Berkhamsted suit came noteworthy struggles with regard to several South London commons. In 1865 Plumstead Common, of 110 acres, and Bostall Heath, of 55 acres, and 25 acres of Tooting Common were enclosed. The two former commons formed part of the wastes of Plumstead, the lords of the manor being the Fellows of Queen's College, Oxford, whose steward, after a series of acts of aggression and encroachment, enclosed about 74 acres of Plumstead Common, the whole of Bostall Heath, and a village green 5 acres in extent.

Here, again, the public were fortunate in their champions, for Sir Julian Goldsmid and Mr. John Warrick were found ready, with the backing of the Commons Society, to challenge the legality of the enclosures.

The College set up a claim to be entitled to enclose under the Statute of Merton, with or without the consent of the freeholders, and asserted that the rights of common had been abandoned or extinguished.

On every point the lords of the manor were worsted, both in the Chancery Division and in the Court of Appeal. It was definitely laid down that one freehold tenant of the manor could sue in defence of rights of common on behalf of himself and all other freehold tenants, and that his rights of common were not lost if he neglected to pay his quit rents to the lord of the manor. This common now belongs to the London County Council, together with 62 acres of a beautiful wood adjoining it.

Tooting Graveney Common is one of the most delightful of our southern open spaces. Clumps of gorse and underwood, interspersed with well-grown trees, and a broken and irregular surface successfully simulate an unspoiled rural common of considerable size. It is, nevertheless, only 66 acres in extent, and is surrounded by a dense population. Its near neighbour, Tooting Bec Common, is 151 acres in extent.

Tooting Graveney is in the manor of that name, and the well-preserved Court Rolls show that it possessed all the attributes of normal manors. The common and some copyhold tenements were bought in 1861 by a Mr. W. S. Thompson for the sum of £3,650, it was hoped, by his neighbours, in order to preserve it for the public use. But "hope told a flattering tale," and after Mr. Thompson had endeavoured to induce the Inclosure Commissioners to bless a proposal to enclose all, and, subsequently, a portion of the common, he fenced in 25 acres of the land in 1865. Three years later the fences were broken down by the commoners, and on the advice of the Commons Society proceedings were commenced against Mr. Thompson by Mr. Betts and two other commoners. Again the plea was put forward that by non-user the rights of common had been lost, and that, as lord of the manor, Mr. Thompson was entitled to enclose the common under the Statute of Merton, since, as it was urged, the freehold tenants were not aggrieved.

The hearing of the action lasted for eleven days, before Lord Romilly, and, on appeal, for six more days. In each count the commoners triumphantly vindicated their claims. "Mr. Thompson," said Lord Hatherley, in pronouncing the judgment of the Court of Appeal, "had purchased the manor for a comparatively small sum, and if he had succeeded in depriving the freeholders of all rights would have made a very handsome profit, and he seemed to have considered that, being the lord of the manor, his title could not, without difficulty, be displaced. In that speculation he had been disappointed."

Tooting Common was thus rescued from the hands of the speculative builder, and represented one more link in the long chain of striking victories which marked the advent of the Commons Preservation Society. The manorial rights in Tooting Graveney Commons were subsequently bought by the Metropolitan Board of Works.

By way of contrast it is only fair to note that all lords of manors did not show the same complete disregard of the public interests in commons as was manifested at Tooting Graveney, Plumstead, Berkhamsted and Hampstead. For instance, in the case of Streatham Common, which is distant less than a mile from Tooting Bec, the Ecclesiastical Commissioners, as lords of the manor, not only became willing

parties to a regulation scheme, but also conveyed their manorial rights to the public for the nominal sum of £5.

This common is 66 acres in extent, and rises to a considerable height over the surrounding district. It is pleasantly undulating and picturesque, and, at the instance of a committee formed by Mr. Stenton Covington, it has recently been enriched by the addition of the charming grounds of the Rookery, in which is to be seen the ancient pump-house of Streatham Wells.

In chronological order Wimbledon and Wandsworth Commons were the next to be saved.

The rejection by the House of Commons of the arrangement proposed by Lord Spencer in 1865 led to an estrangement of the relations between the lord of the manor and the commoners. The owner showed that he took a somewhat narrow view of the legal position and of the public interests; and the commoners, on their part, felt that their rights were so extensive as to render their approval necessary to any proposals with regard to the commons. Lord Spencer was lord of the manors of Wimbledon, Putney, Battersea and Clapham, and in consequence of the acute differences of opinion which existed as to the manorial and commoners' rights, proceedings were initiated by Sir Henry Peek against Lord Spencer in 1866. The unexpected discovery that, in respect of a large area of land not previously taken into consideration, common rights existed, rendered possible a compromise, and the litigation was happily abandoned.

The compromise provided that Lord Spencer should convey all his rights in Wimbledon Common and Putney Heath to a board of eight conservators, receiving in return an undertaking for the payment of a perpetual annuity of £1,200. In order to raise this sum, and to meet the expense of maintaining the common as an open space, the novel principle was introduced of levying a rate upon all dwelling-houses annually assessed at or over £35 situate within three-quarters of a mile of the common. The occupiers were to be taxed in proportion to their nearness to the common in one quarter of a mile zones, an interesting and successful experiment which might be repeated in other neighbourhoods where the provision of an open space is calculated to lead to the betterment of surrounding property. This arrangement was confirmed in 1871 by a special Act of Parliament, and Wimbledon may be congratulated upon the consummation of a scheme which fully justified the strenuous opposition to the original proposals.

Wimbledon Common thus saved was already one of the most spacious, as it is also one of the best-known and most beautiful open spaces in the neighbourhood of London. The rapid development of the district has rendered necessary a further effort to protect from disfigurement that which had only been saved at the cost of so much sacrifice. A committee, inspired by Mr. Richardson Evans, has been strenuously working for over six years to acquire the land lying between the common and Richmond Park and along the borders of Beverley Brook. The bulk of this land has been already secured and added to the common. The completion of the scheme would protect the amenity of the existing land and furnish an unbroken area of open space extending from Putney and Wimbledon to Kingston, Ham and Richmond.

Wandsworth Common was dealt with on somewhat similar lines to those which ensured the safety of Wimbledon Common, though without the rating provisions. In consideration of an annuity of £250 the interests of Lord Spencer were conveyed to a board of conservators, to be afterwards transferred to the Metropolitan Board of Works, and subsequently to the London County Council.

This open space is an object-lesson of the manner in which commons suffered in past days. It is now 175 acres in extent, but until 1782 had more than double that area. Constant encroachments took place for private or semi-public purposes, the last being the enclosure after the Crimean War of 60 acres to form a site for the Royal Patriotic Society's Schools, the commoners having generously surrendered their rights in order that this might be accomplished. Twenty acres of this land were bought back three years ago and added to the common at a total cost of £12,000.

This common, too, was cruelly used by the London, Brighton and South Coast and London and South Western Railway Companies, whose disfiguring lines were allowed to cut it up into disjointed blocks, gravely interfering with its utility as an open space. Railway companies have indeed much to answer for, since, in scores of cases, their lines would seem to have been deliberately planned to traverse the maximum quantity of common land. Such harmful attacks were carried out with impunity until the Commons Preservation Society fought the Private Bills in Parliament, and by defeating

many injurious schemes compelled railway companies to recognise that the risk of losing their Bills was too great if, in order to cheapen the cost of construction, their lines were planned in such a manner as seriously to injure commons. Every railway, water, and other private Bill now introduced into Parliament is closely scrutinised by the society, which, thanks to general support from all political parties, has been the means of saving tens of thousands of acres of common land from appropriation.

It is now necessary to tell the story of the preservation of Epping Forest, perhaps the most beautiful as it is the largest of London's open spaces. The forest, as it exists to-day, is 5,559 acres in extent. Great as is this area, it is but a shred of the once vast Forest of Waltham of which it formed part.

It runs from Wanstead Flats to Epping as a belt of sylvan scenery over thirteen miles in length. Here and there—as at High Beech—are to be found groves of well-grown beech and oak. For the most part, however, the forest consists of spacious woods of pollarded hornbeam and oak, broken at irregular intervals by ancient clearings and leafy glades.

Epping was a Royal Forest, which is defined by Manwood as " a territory of woody grounds and fruitful pastures, privileged for wild beasts, and fowls of forest, chase and warren, to rest and abide there in the safe protection of the King, for his delight and pleasure." In those far-off days when Royalties amused themselves by chasing the deer, everything in the forest was subordinated to the sport. No fences around ancient enclosures within the ambit of a forest must be sufficiently high to exclude a doe with her fawn; the cottager must not drive the deer from his crops, and no buildings could be erected " because of the increase of men and dogs and other things which might frighten the deer from their food."

The Crown rights were gradually diminished by sale or disuse, but even in 1793 the area of the open forest was reported by the Land Revenue Commissioners to be 9,000 acres. The forest was already largely frequented by Londoners for recreation, for the commissioners said that it was most important that nothing should be done to countenance its enclosure, and especially so because of its close proximity to the metropolis.

Notwithstanding this remarkable testimony to the public requirements, encroachments upon the forest were allowed to be made with impunity and with an ever-increasing frequency. The result was that by 1848 Epping Forest was reduced to an area of 7,000 acres.

The Crown then took a step which had dire effects. It offered to sell to lords of manors within the forest its forestal rights at the rate of about £5 per acre. The sale of the Crown rights over 3,513 acres followed, and produced £15,793.

Lord Mornington, who had considerable manorial interests, had previously begun to enclose, though bound as its Lord Warden to protect the forest, and by 1851 the open forest had been whittled down to 6,000 acres. This was but a foretaste of what was to follow, for in the next eighteen years the forest, by enclosure, had shrunk to 3,000 acres.

The worst of these encroachments took place in the Manor of Loughton, where the rector and lord of the manor, Mr. Maitland, appropriated in 1866 about 1,300 acres at one scoop. Before doing so he endeavoured to come to terms with the copyholders, who constituted the recognised commoners of his manor. Some were overridden, and other placated by promises of a share of the spoil.

The rights and interests of the general inhabitants were completely ignored, although from time immemorial they had enjoyed the right of lopping the trees for firewood during the winter months, from St. Martin's Day, November 11th, to St. George's Day, April 23rd. " It was," as Lord Eversley observes in his book, " the tradition of the people that this custom had its origin in a grant from Queen Elizabeth, and that it was conditional on their commencing to lop the trees as the clock struck the hour of midnight on the preceding night. They were wont to meet for that purpose at Staples Hill, within the forest, where, after lighting a fire and celebrating the occasion by draughts of beer, they lopped from twelve o'clock till two o'clock, and then returned to their homes. The branches, according to the custom, could not be faggoted in the forest, but were made into heaps 6 ft. high, and were then drawn out of the forest on sledges. In olden times the first load was drawn out by white horses. The wood could only be cut for the use of the inhabitants of the parish.

" It is said that about a century ago the then lord of the manor, wishing to extinguish the custom, invited all his parishioners to a banquet on the eve of St. Martin's Day, and plied them plentifully with liquor, in the hope that midnight would find them in such a condition that they would be unable to perambulate the forest so as to maintain their rights. One man, however

kept his head clear of liquor, and stole from the feast at midnight, perambulated the forest, and exercised his right by lopping some trees, and having done so returned to the feast, where he found his friends still being plied with drink. The lord thereupon, angry at the failure of his scheme, bid them begone with many curses."

On St. Martin's Day in the year 1866, a labourer named Willingale with his two sons determined to exercise their ancient custom of lopping trees for firewood. For this act they were sent to prison for two months with hard labour, and it afterwards transpired that one of the adjudicating magistrates had himself received an allotment from the common over which the Willingales asserted their rights.

At this stage the Commons Society, led by Lord Eversley, intervened, and determined to arouse public opinion upon the subject and to test the validity of the enclosure. For this purpose a guarantee fund of £1,000 was raised by the society, and a suit was commenced in the name of Willingale, claiming on behalf of the inhabitants of Loughton a right to lop the trees for firewood.

The case dragged on, the commoners being gravely hampered by lack of funds to make the necessary, but extremely expensive, researches into the history of the forest. Again and again it almost seemed as though the cause must be abandoned. Again and again, as the minute books of the Commons Preservation Society show, it was only through the splendid generosity of the late Sir T. Fowell Buxton and his brother, Mr. Edward North Buxton, that it was found possible to continue the task. Mr. Buxton's interest in the saving of London's open spaces still continues, and his services to the cause, through the Society and otherwise, have been beyond all praise.

Willingale died in 1870 and his death abated the proceedings. His suit had stopped the destruction of the trees and enabled vitally-important inquiries to be completed, and it was believed that if a commoner possessed of ample means could be found willing to challenge the enclosures there was every prospect of success.

Such a commoner was found in the Corporation of the City of London in respect of an estate of 200 acres at Little Ilford. The Corporation were prevailed upon to take up the cudgels on behalf of the public, and the society's then solicitor, the late Sir Robert Hunter, was associated with the City solicitor in the conduct of a fresh suit.

It was discovered by Sir Robert that, although there were nineteen manors in Epping Forest, the forest itself was one great common, so that the commoners of every one of the nineteen manors had the right of turning out their cattle to graze, without confining them to their particular manor. The Corporation therefore initiated proceedings against sixteen lords of manors.

In the meantime a scheme was put forward in Parliament by the then First Commissioner of Works which proposed that, of the 3,000 acres of open forest still remaining, 2,000 should be given up to the lords of the manor, 400 sold to provide compensation for the commoners, and 600 secured for the recreation and enjoyment of the public. In the light of the subsequent course of events it now seems remarkable that this extraordinary scheme was endorsed by the Government, and might easily have been carried. But the society offered determined opposition to the proposals, which were eventually defeated. A Royal Commission was then granted to inquire into the condition of the forest.

The suit of the City Corporation eventually reached the Court of the Master of the Rolls, Sir George Jessel, and after a most protracted hearing, the arguments alone occupying twenty-three days, it was decided that there was a general right on the part of the commoners to turn their cattle on to the whole of the waste of the forest and that the lords of the manors had no right to make enclosures. This remarkable victory was a complete justification of the policy of the society in rejecting the many attempts which had been made to compromise.

It is unnecessary to recount the doings of the Royal Commission, though they sat for 102 days, save to say that they came to the same conclusions as the Master of the Rolls. They, however, proposed that the lords of manors should be allowed to keep 700 acres which they had wrongfully enclosed, paying rents to form a fund for managing the residue.

Subsequently, the City Corporation bought up the rights of many of the manorial lords, and in 1878 a Government measure was introduced vesting in the Corporation the future control and management of the forest. It directed that all land illegally enclosed, *i.e.*, land enclosed within twenty years of the commencement of the Corporation suit, should be restored, except where it had been already built upon, and it made suitable provisions for the permanent preservation of the forest as an open space. An arbitrator, Lord Hobhouse, was appointed to decide questions with reference to rights and enclosures, and in 1882 his award was presented,

directing the restitution of over 3,000 acres of common land which had been wrongfully enclosed.

The Corporation had spent £33,000 in legal expenses in connection with its great suit. It subsequently added to the forest Wanstead and Higham Parks, and its total capital outlay in buying out the manorial rights and in safeguarding the forest has amounted to not less than £293,252. By its action it has placed the metropolis under a debt of gratitude in part repaid by the knowledge of the enjoyment brought to many thousands by the preservation of London's premier open space.

In the case of other commons the Corporation has also taken noteworthy action, for it acquired, and now holds for the public, Coulsdon Commons, Burnham Beeches and West Wickham Common.

The commons of the manor of Coulsdon are about 347 acres in extent, and were not saved without a bitter fight.

They consist of fine stretches of down land known as Riddlesdown, Kenley Common, Coulsdon Common and Farthingdown, and the lord of the manor, Mr. Byron, after vainly endeavouring to secure their enclosure by an Inclosure Act, strove to enclose parts of the commons and impaired their utility by the wholesale removal of turf. An action brought against Mr. Byron by Messrs. Hall terminated in 1877 in another substantial victory. The enclosures were ordered to be abated and the destruction of the surface of the commons was restrained. The City Corporation subsequently acquired the manorial rights.

The saving of Burnham Beeches was accomplished in a very different manner. This weirdly-beautiful open space is a common of 375 acres, and its ancient groves of beech trees form pictures of sylvan grandeur quite unequalled in any other part of this country. The common had long been included in the estate of the Grenvilles, and for a considerable time arbitrary acts of repression had been bitterly resented by the villagers, who had been accustomed to cut peat in the swampy parts of the common and firewood in its coppices.

In 1879 it was announced that the manor and the common were to be submitted for sale at auction, and expectations were held out that the purchaser would be able to enclose. A deputation of leading members of the Commons Society and the Kyrle Society waited upon a Committee of the City Corporation to urge that they should add to their good work by acquiring Burnham Beeches. It was accordingly bought by Sir Henry Peek and transferred to the Corporation for the sum of £6,000, or less than £20 per acre.

In the meantime the last of the great suits with regard to metropolitan commons had been commenced. This affected the commons of the manor of Banstead. These are known as Banstead Heath, Banstead Down, Park Down and Burgh Heath, which, in the aggregate, comprise over 1,300 acres of breezy downland in North Surrey. The manor in 1873 came into the possession of Sir John Hartopp, who commenced operations by endeavouring to buy the rights of the commoners. To some, money payments were offered by way of compensation for the surrender of their rights, to others the tempting offer was made of the enfranchisement of their holdings free of charge.

It is said that Sir John Hartopp expended in this manner the sum of £18,000, and by 1876 he felt that he had so far progressed with his scheme of getting rid of the commoners' rights as to render safe the enclosure of the commons. He started by erecting houses on Banstead Downs and by enclosing parts of the heath. A local committee was formed, under the direction of the Commons Society, to resist the enclosures, and two of its members, Mr. J. N. Robertson and Mr. H. Fletcher, as freeholders, with two copyholders, agreed to allow their names to be used for the purposes of legal proceedings.

For weary years the fight dragged on, and many preliminary skirmishes occurred before the main action was heard. Moreover, in 1884, Sir John Hartopp's solicitors became insolvent, involving in their ruin the lord of the manor. Two ladies who had been unfortunate enough to advance £31,000 upon the manorial property now took possession of the common under their mortgage deed, and by excessive gravel-digging and turf-paring, threatened to ruin the surface of the commons. The suit was therefore revived as against these ladies.

At length, in 1886, after a lengthy hearing, Mr. Justice Stirling restrained the lord of the manor from enclosing or destroying the pasturage of the commons, but left to a referee complicated questions as to the nature and extent of the rights of common. After researches extending over a further two years, it was abundantly proved that, notwithstanding Sir John Hartopp's efforts to extinguish the rights of common, those that remained were so extensive that, if exercised to their fullest extent, insufficient

pasture existed to supply the needs of the commonable beasts.

In 1889 Mr. Justice Stirling delivered his final judgment in this case in favour of the commoners. This decision was upheld by the Court of Appeal, and subsequently, after a further bitter struggle, the management of the commons was conferred upon a board of conservators by means of a scheme under the Metropolitan Commons Act.

This triumphant victory was not finally achieved until 1893, and the fight had lasted since January 1877.

The result of these many successes was to discourage further attempts at the enclosure of metropolitan commons. It was proved that it was not safe for lords of manors to rely upon the ancient Statute of Merton, on the pretext that they had left open sufficient common for the needs of the freeholders. When put to the test, in every case the defence failed. But while the Statute remained unrepealed or unamended it was a constant menace to every common. Accordingly, in 1893, the society induced the late Lord Thring to introduce a Bill into the Upper House providing that, in future, no enclosure of common land should take place without the consent of the Board of Agriculture, who in giving or withholding their consent were to be bound to take into consideration public as well as private interests. This Bill passed under the title of the Law of Commons Amendment Act, and, it is hoped, has tolled the death-knell of the enclosure movement.

In all these involved proceedings the society was well served by an exceptionably able group of legal advisers. Its first solicitor, Mr. Philip Lawrence, performed yeoman service in the early suits, establishing principles and winning victories in circumstances of great and novel difficulty. His successor, the late Sir Robert Hunter, afterwards Solicitor to the General Post Office, and the chairman of the National Trust, had the conduct of many of the suits, including the Epping Forest litigation, and to his alert mind, amazing knowledge of the law of commons, and persistent effort, much of the success of the society is due. The tradition of these solicitors has been ably maintained by Mr. Percival Birkett, who carried through to victory the complicated Banstead case.

Mitcham Common, another of the large metropolitan open spaces, is 570 acres in extent and has also been the cause of much litigation, both in regard to encroachments and as to the rights of the members of a golf club to play golf over part of it. It was eventually regulated in 1891 under the Metropolitan Commons Act. This Act, indeed, has had most marked results, for it has been employed to safeguard 4,171 acres of common land in and about London.

There still remain about 2,300 acres of unregulated commons in the metropolis, of which the most important are those in the parishes of Epsom and Thames Ditton. Every common ought certainly to be placed under regulation, not only in order to ensure the maintenance of law and order, but also because a regulation scheme ensures the preservation of the common as an open space.

Amongst the many other fine commons to which the machinery of regulation has been applied, are Clapham Common and Peckham Rye. The manorial rights in each of these open spaces are now vested in the London County Council. Clapham Common is 220 acres in extent, and is of great service to cricket, hockey, tennis and football players. Peckham Rye (64 acres) is likewise a popular resort. The claim of the lord of the manor to enclose this common was strongly contested before the Select Committee in 1865, the dispute being subsequently settled by the purchase of the manorial rights.

An interesting circumstance in connection with the commons and parks of London is the extensive use to which they have lately been put for military exercises and evolutions. It is not too much to say that the protection of these open spaces and rural commons, too, has of late, been the means of saving the country vast sums of money which must otherwise have been spent in providing training grounds for troops. Villagers have cheerfully acquiesced in the temporary appropriation of their greens and commons, confident that, when the national exigencies permit, they will be restored again to popular use.

It must not be thought that because the work of the society during the last fifty years has been buoyed up by so much success, nothing further remains to be done. The history of the protection of rural commons is another story, and results have been achieved in the country as remarkable in their way as those which have followed the efforts of the society in and about London. An entirely new spirit prevails, for the Inclosure Commissioners, whose object it was to facilitate the enclosure of commons, have ceased to exist. Their place has been taken by the Board of Agriculture, which is

bound to have regard to the public rather than private interests. It is no less than their due to say that the permanent officials of the Board have earned the thanks of the community for the enlightened way in which their duties are now performed.

Nevertheless, signs are not wanting that some persons unacquainted with the past history of commons, with the economic ruin that their enclosure often brought about, and with their value to the public as open spaces, would exploit the country's present difficulties in the matter of food supply by urging that every inch of common land should be enclosed and cultivated. They overlook the fact that most of the commons which succeeded in escaping the widespread net of the enclosure movement, owed their escape to the circumstance that their soil is of too poor a quality to render cultivation profitable. They overlook, too, the truth expressed in those wise words, "Man shall not live by bread alone." Even if it does not grow an ear of corn, a common is a national asset. In America, vast reserves of land have been set apart for the use of the community. Our commons are natural reserves which it would be folly to sacrifice upon the altar of utilitarianism while millions of acres of enclosed land lie idle in a productive sense. Then, too, undesirable schemes of afforestation require to be watched; illegal enclosures are still constantly taking place, and within the last few months it has been necessary to fight for the modification of arterial road schemes, one of which as originally proposed would have gravely injured Epping Forest.

Fifty years ago, when the small band of seven men, led by Lord Eversley, determined to fight against the absorption of metropolitan commons, they could scarcely have dared to look for the startling results to which their action was destined to lead. The society formed by them has always had to struggle against financial difficulties, more especially as it was soon found necessary to increase its scope so that it might safeguard rural as well as metropolitan commons, and protect footpaths and other highways as well. There were in 1865 about 16,320 acres of common land within the Metropolitan Police District. Much of this had been fenced in, and lords of the manors claimed the right to enclose the whole without regard to the wishes of the community.

Thanks to the crusade inaugurated by the society, of that great area it is probable that less than 200 acres have passed into private hands. Other portions, totalling perhaps a rather larger acreage, have been taken for waterworks and other semi-public purposes. Of the amount remaining, about 14,000 acres have been definitely secured for ever by the many suits fought under the direction of the society, or by purchase or regulation, and about 2,300 acres, though available for public use, remain to be dealt with.

The total area of open spaces to which the public have access, including all commons, and royal parks—such as those at Richmond and Bushey—in the Metropolitan Police District is approximately 25,431 acres, of which 15,900 acres are or were common lands. If brought together into one large tract the open spaces of London would occupy an area of about forty square miles, or if extended into a line they would form a continuous strip over three-quarters of a mile broad, stretching from London to Brighton.

Yet no one would assert that London is too well equipped with facilities for recreation when it is realised that there is but one acre of open space in London proper for every 678 inhabitants, while in Southwark the proportion is far less, for it is only one acre for every 14,499 persons.

London has been fortunate in possessing, beyond the Commons Society, other open space organisations such as the Metropolitan Public Gardens Association, which has done so much to preserve square gardens and disused burial grounds, the Kyrle Society, and the National Trust. These four societies have been closely associated in formulating or assisting nearly every London open space scheme launched during the past thirty years.

The whole movement, too, has been greatly stimulated by the ardent band of champions of public rights who gathered around Lord Eversley, sinking political and other convictions in the one aim of saving the people's commons. Many have been already alluded to; amongst others who should be named are the late Professor Fawcett, Mr. John Stuart Mill, Sir Charles Dilke, Mr. C. Buxton, Mr. W. H. Smith, Professor Huxley, Mr. Samuel Morley, the Duke of Westminster, Dean Stanley, Miss Octavia Hill, Lord Bryce, Mr. Edward Bond, Sir John Brunner, Mr. J. F. L. Brunner, M.P., Mr. Briscoe Eyre, Sir Frederick Pollock, and our chairman of to-day, Lord Farrer. Many others could be added to this short list.

Most of the early members have passed away, but not before seeing generally accepted the great principles they set before themselves, and not before knowing that the bulk of the

common lands of London had been placed beyond the possibility of successful attack. Though they have gone to their rest, the ceaseless vigil of the people's watch-dog, as the society is known in Parliament, goes on; for the members are resolved to be ready to sound the alarm when fresh invasions of public rights are threatened, and ready too, if need be, to fight again in defence of the national heritage—our common lands, for

"There the turf
Smells fresh, and, rich in odoriferous herbs,
. . . regales the sense
With luxury of unexpected sweets."

DISCUSSION.

THE CHAIRMAN (Lord Farrer), in inviting the meeting to discuss the paper, desired to say how much he appreciated Mr. Chubb as secretary of an unobtrusive body which had done the largest amount of work with the smallest amount of money of any society he had come across. He might mention that the author was not Mr. Chubb of Salisbury, who had bought Stonehenge and charged the public for admission, but Mr. Chubb of the Commons and Footpaths Preservation Society. He did not think that anybody who had not been daily brought into contact with Mr. Chubb realised the great work which he did, day in and day out, in endeavouring to protect the interests of the public. It might fairly be asked what was the reason of the success of the movement—for successful it had unquestionably been. In thinking it over, it seemed to him that it was because it was a form of what might be termed sane State Socialism, that was to say, a form of public enjoyment against mere private rapacity. It was very interesting to go back, as Mr. Chubb had done, to 1265, and notice that human nature had not changed very much in the seven centuries that had elapsed. In those days, and possibly now, there were land-grabbers in Europe. The Norman kings loved hunting; to-day people were more cultivated and were fond of Nature in other aspects, and the Commons Preservation Society undoubtedly tried to preserve those aspects to the inhabitants of towns. He had been very much interested lately, in going through the camp on Witlay Common, to notice that that lovely common had been converted by the War Office into a most hideous waste, and to notice that, although the people at the head of affairs had put up a large gas factory, the soldiers were cultivating small gardens around their huts. The lord of the manor, Lord Midleton, he believed, had an agreement to the effect that at the end of the war the common was to be restored to its original condition, but it would take some little time to do that. There was one other branch of work which Mr. Chubb was interested in, namely, the preservation of footpaths. His (the speaker's) view was that the English law was very favourable to the public as compared with the laws of other countries with which he was acquainted, as it enabled the people of this country to enjoy commons in a way that was not possible in countries under the Napoleonic Code. He himself went back to the old Shakespearean tag—

"Jog on, jog on, the footpath way
And merrily hent the stile-a:
Your merry heart goes all the day,
Your sad tires in a mile-a!"

MR. WALTER F. REID said he had had the pleasure of knowing Mr. Chubb for many years, and knew that he had not only done good work with regard to the preservation of commons and footpaths, but in other directions also. He had been interested in the remark made with regard to the growth of juniper bushes near London, because Mr. Chubb happened to be the Secretary of the Coal Smoke Abatement Society, and the efforts of that society had materially improved the atmosphere. A great deal of the success was due to the energy and tact of Mr. Chubb. He had never heard a paper which was so clear, definite and eloquent, and he believed it would be a work of reference on the subject of commons.

MR. JAMES ELLIS said that when the great services Mr. Chubb had rendered to the public were known, he would receive much more recognition and the receipts of the society would be greatly increased. For many years he himself had been personally familiar with the commons that had been saved to the public, and he knew that Lord Eversley and Mr. Chubb had rendered services beyond all price, and were amongst the few men who enjoyed the confidence of men of all shades of politics, and stood high in the esteem of everyone acquainted with their work. Mr. Chubb was an authority on the rights of the public, and was often called in by agreement between parties to act as arbitrator, and his judgment was trusted and accepted and treated as final.

On the motion of the CHAIRMAN a hearty vote of thanks was accorded to Mr. Chubb for his interesting paper.

MR. CHUBB, in responding, said he greatly esteemed the kind words which had been spoken with regard to him. It was a genuine pleasure to be the secretary of an organisation such as the Commons Preservation Society, with regard to which he felt it possible to put his whole heart into the work. It had been a very great pleasure to him to prepare the paper, and endeavour to tell the story of what had been done by members of the society.

CORRESPONDENCE.

THE VALUE OF BIRDS TO MAN.

In the issue of your *Journal* for October 29th I see a letter from Mr. James Buckland in reply to mine which appeared in the issue of August 20th.

All bird lovers in Jamaica fully appreciate Mr. Buckland's efforts for the better preservation of bird-life, but I for one cannot think that the cause is helped by statements unsupported by evidence, by theories that seem almost fanciful, and by charges of deadness and slumber, which are ill-deserved.

Mr. Buckland says: "It is not at all certain that the importation of infected cattle was the agency by which the tick pest was first introduced into the island." The outcry against ticks certainly arose after the first importation. There were ticks before, but no tick plague.

Mr. Buckland expresses the opinion that the Texas fever tick was brought to Jamaica by the wind. If he had seen the ticks on the stock imported from the regions where Texas fever is a well-known plague he would hardly have felt it necessary to credit them with so fanciful a flight. He quotes the report of the Twenty-first Expedition of the Liverpool School of Tropical Medicine for his own purpose, but he carefully abstains from quoting it where it says: "A small proportion may be wind-borne, though it is doubtful if such an agency would carry 'grass lice' to any great distance from an infected area."

Mr. Buckland says: "The number of bird skins from Jamaica which poured into Europe and into New York City when the slaughter was at its height is truly appalling. It is not easy for me to recall to memory the hundreds of thousands I have seen in England, France, Holland, and Germany, without the feeling of indignation I experienced at the time again rising within me." Can he give any proof that these bird skins came from Jamaica? There is no proof to be obtained in Jamaica. There has not been any considerable export of bird skins from Jamaica within living knowledge. He says: "Whole species have been wiped out of existence, while of those that were most abundant only a pitiful remnant remain." Which species? Of the 194 birds of Jamaica enumerated by Alfred and Edward Newton in the "Handbook of Jamaica for 1881" the following notes were made by the late Dr. Sclater when he published a revision of the list in the "Handbook" for 1910:—

The long-nostrilled night-jar (*Siphonorhis americanus*) is marked as "very rare and possibly now extinct"; the Jamaica macaw (*Ara gossii*) is "almost if not quite extinct"; the blue dove (*Geotrygon cristata*) is "said to be becoming extinct since the introduction of the mongoose"; the northern courlan (*Aramus giganteus*) is "now nearly extinct"; the Blue Mountain duck (*Oestrelata jamaicensis*) is "supposed to be now extinct." Of these none but the macaw could possibly have tempted "gunners" as "birds which carried marketable feathers." It cannot be said that the insect-eating small bird is as a rule so beautiful as to appeal to the milliner.

Mr. Buckland states that "native breeds of cattle enjoy an almost total immunity from the plague of tick-fever, while imported cattle suffer terribly." By "native" he possibly means creole cattle. These suffer far more than imported Indian cattle, which are practically immune.

Mr. Buckland says that "the Birds and Fishes Protection Law is a sham and fills the mouth of the gunner with laughter." Practically the only "gunners" in the island are those who shoot in due season the various forms of pigeons for the table. The cost of the gun licence and ammunition certainly act strongly against the wanton destruction of birds by means of firearms by the ignorant classes.

Mr. Buckland considers that it is easy "for the bird under natural conditions to keep the tick in check." There are few in Jamaica who will agree with him, if natural conditions include the keeping of cattle; for the tick is a favourite food of but a limited number of birds, and the ticks were certainly gaining on their natural enemies before the introduction of the mongoose. Mr. Buckland mentions that "seventy-four adult ticks, all females in an engorged condition, have been taken from the stomach of a bird after its early morning meal." He does not state that the bird was (as given by the authority from which he gleaned his information) a tinkling grackle, which is protected by law.

Mr. Buckland says: "Mr. Cundall states that the island of Jamaica is remarkably suitable for the breeding of cattle," and says this is untrue. I quoted the words of the Director of Agriculture, whom Mr. Buckland had quoted in his previous paragraph as saying that "experience teaches us that there is no such thing as immunity for an imported dairy cow in Jamaica, and we must expect all our imported cows to succumb to tick-fever sooner or later." The two remarks are compatible. One might as well say that because Europeans on first coming to the tropics are more liable to disease than old stagers that the tropics are not suitable as a home for Europeans and their creole offspring!

Apart from bird-lovers there are those who are naturally deeply concerned to preserve all insect-eating birds, useful to man, directly or indirectly, through their value to the agriculturist. But to enlist the aid of the people, especially the peasant employed in agriculture here, and to educate the youth of the country out of his ingrained propensity toward the destruction of birds by means of stones, springs, and catapults, one must use arguments based on well-established facts and not on fanciful or theoretical beliefs, at which he will softly smile. The paroquet, which has been lately removed from the totally protected to the partially protected schedule in the law, is most destructive to oranges and other fruit, more still

to the poor man's corn, and has increased enormously in the thirty years of "protected" life, and the hawks not only prey on poultry and domestic pigeons, but are the chief foes of the small insect-eating birds, far more so than the imaginary "gunners."

Mr. Buckland appears to be obsessed with the idea that the bird-life of Jamaica is being destroyed by the hunter for birds which carry marketable feathers, and seems to base all his arguments on a statement in proof of which he offers no evidence, and which, with full local knowledge, I assure him is incorrect. He is equally incorrect in the gloomy view he takes of the results of the present efforts of stock-owners in combating the tick pest. The results of the dipping and spraying which very many pen-keepers now diligently practise are just as encouraging as the results of similar efforts in the many other countries where they have become necessary.

FRANK CUNDALL.

Kingston, Jamaica.
December 28th, 1915.

NOTES ON BOOKS.

HISTORIC JAMAICA. By Frank Cundall, F.S.A., Institute of Jamaica, and West Indian Committee. London, 1915.

The island is fortunate in having so earnest and persevering an archæologist as the Secretary of the Institute of Jamaica to undertake the duty of recording the plans and objects of historical interest which it possesses. The history of Jamaica appears to commence in 1655, when it was taken from the Spaniards by an expedition sent out by Cromwell. Before that date little is known. Research and excavation have discovered almost nothing about the inhabitants of the island before its discovery by Columbus, and "with regard to the Spanish occupation of the island, both history and archæology are almost as scantily supplied as in the case of the Arawâks."

It is, therefore, only as an English colony that Jamaica has a history. Her prehistoric ages extend down to the middle of the seventeenth century. For the two-and-a-half centuries of recognised existence the records are complete enough, and the materials for writing its political history are sufficient. The list of Governors is complete, from General Doyley in 1661 to Sir W. H. Manning in 1913. The changes in the methods of administration are all set out in the authorities where such matters are recorded, while the naval victories, which are the chief glory of West Indian history, have been fully and worthily dealt with by our historians.

It is not, however, of such high matters that the present volume deals, but with the actual existing objects of historical interest which have survived the disintegrating influence of a tropical climate and the destructive efforts of the ignorant destroyer, the renovator and the religious reformer.

In 1900 Mr. Cundall published an account of some of the more important historic sites in Jamaica. In 1908 the West Indian Committee, moved by the appointment of the Royal Commission on Historical Monuments, appealed to the Colonial Office for similar action in the West Indian Colonies, and the result was that the suggestions of the committee were "recommended for the consideration" of the Governors of those colonies. This non-committal sort of recommendation had its effect in Jamaica, for the result was that Mr. Cundall, "at the request of the Governor," "undertook to prepare a list, parish by parish, of historic sites, buildings and monuments." This list was published officially, and formed part of a Report presented to Parliament three years ago. It also formed the groundwork of a series of articles on the subject, and these again have been elaborated into the present book.

The record is considerable, and appears to be complete, as indeed might be expected from so painstaking a student as its author. It is arranged under the fifteen parishes into which the island is divided, each parish being allotted a chapter to itself.

There is also an historical introduction dealing with the original inhabitants, the Arawâks, the Spanish occupation, the English possession, the physical features of the island, its products, etc. Amongst other matters may be noted a good account of the Botanic Gardens of Jamaica, since it was due to the efforts of the Society of Arts, from 1760 onwards, that the first attempt was made to establish in the West Indies "gardens or nurseries for the making experiments in raising such rare and useful plants as are not the spontaneous growth of the kingdom or of the said colonies."

THE ARCHITECTURE OF ANCIENT EGYPT. By Edward Bell, M.A., F.S.A. London: G. Bell & Sons, Ltd. 6s. net.

Recent research has thrown a great deal of fresh light on the history of architecture in Egypt, and though much has been written in special books and papers on the various points dealt with in these researches, this would seem to be the first attempt to bring together the fresh information in a connected and easily accessible form.

One of the facts which Mr. Bell does well to emphasize, is the great length of the period over which the development of Egyptian architecture extended. Owing to the way in which the subject is frequently treated in text-books dealing with the history of architecture generally, the casual student is apt to gain the impression that the so-called "orders" were contemporaneous, and that the Egyptian

period was more or less of the same length as the classic period. It is, of course, impossible to trace the history of the art to its very beginnings, but in his chapter on prehistoric and dynastic Egypt the author makes it clear at once that Egyptian architecture was flourishing in the Old Kingdom in the fourth millennium B.C., and that its period extended over three or four thousand years. It is curious that in all this length of time there was so little tendency towards progress; for although the various "orders" had their own features, the main characteristics of Egyptian architecture remained peculiarly distinctive and unaltered. This permanent nature of the art is generally recognised as being due to the conservative influence of the priesthood, and it is a striking proof of their power that they were able to persuade even foreign conquerors to adopt the native superstitions and religions.

The book is copiously illustrated with photographs, drawings, maps and plans, which add very materially to its interest and value.

THE TELEPHONE AND TELEPHONE EXCHANGES. By J. E. Kingsbury, M.I.E.E. London: Longmans, Green & Co. pp. 558. 12*s*. 6*d*.

This is a very complete history of the origin, growth, and development of the telephone from its inception in the work of Graham Bell and his father on "Visible Speech" down to its elaboration in the modern exchange. Practically the book divides itself into two parts, the first being more or less the early history, and the second half an account of the existing system, with details of the arrangements of exchanges with all their complicated organisation and elaborate instruments.

It is not generally known that the word "telephone" anticipated the existence of the instrument to which it is now solely applied. Various devices for transmitting sounds such as speaking-trumpets were called telephones. Mr. Kingsbury mentions an apparatus for conveying signals during foggy weather by means of compressed air forced through trumpets, which is described under the name of telephone in the "Year Book of Facts in Science and Art" for 1845, the inventor being one Captain John Taylor. Murray's Dictionary quotes from the *Times* of the previous year a still earlier reference to this apparatus. From the same authority it appears that the word "telephone" was first applied to a system of signalling devised by Sudro in 1828 and described in Wilson's "New Musical Dictionary" (1834).

Mr. Kingsbury also refers to the gutta-percha telephone exhibited by Francis Whishaw at the 1851 Exhibition. This he thinks was a speaking-trumpet, but it was really an acoustic reflector. Whishaw was not, as Mr. Kingsbury says, a manufacturer, but an engineer, and for some years up to 1845 he was secretary of the Society of Arts. In the year 1845 he read a paper before the Society on the "Uses of Gutta Percha," for the discovery of which the Society's Gold Medal was awarded a few months later to Dr. William Montgomerie. Whishaw realised the value of the material, and he then showed the Society the specimens which Montgomerie had sent from Singapore, and some articles he had himself made from the material, including pieces of pipe, a lathe-band, and some impressions of medals. As nothing is said about a telephone, it is most probable that this device was constructed later. It was shown at a soirée of the Royal Society in the summer of 1849, and really consisted of two large concave reflectors fixed opposite to one another at a suitable distance, so that a message spoken into one was reflected into the other. It was stated that a whisper could be heard at a distance of 40 ft., and that the inventor anticipated that a loudly-spoken tone would be heard at a distance of a quarter of a mile. Whishaw also made speaking-tubes of gutta-percha, but there is no available evidence to show that he claimed to be the inventor of the speaking-tube.

Mr. Kingsbury also refers to Wheatstone's device for carrying musical sounds from one room to another by the use of a solid rod, now a common lecture experiment, and says that Tyndall utilised the illustration in the course of a series of lectures on Sound at the Society of Arts. As a matter of fact, these lectures, though they were mentioned in the *Journal* at the time, had nothing to do with this Society. They were really delivered at the Royal Institution, and were afterwards elaborated into Tyndall's well-known book on Sound. The apparatus formed the basis of Professor Pepper's "Telephone Concerts" at the Polytechnic.

These introductory matters have their interest for those who care for such things, but they are the mere fringe of the subject. The real value of the book is that it provides a very full and apparently accurate account of Professor Bell's researches and experiments which ended in producing the electric telephone as we now know it, with the exception, of course, of the important addition of Professor Hughes's microphone to the telephone transmitter. Due credit is given to Philipp Reis for his early work, and to Professor Hughes and others who co-operated in the development of the instrument. Mr. Kingsbury has the advantage of writing about matters within his own knowledge, and within that of his contemporaries. The general objection to contemporary history, that the point of view is too near, and involves an absence of correct perspective, hardly applies to technical history, in which correct statement is all-important and picturesque treatment is non-essential. If the amount of detail is somewhat excessive, this may well be forgiven in consideration of the fulness and accuracy of the information.

The latter and more technical portion of the book is intended for specialists, and to their notice it may be recommended, for they will find not only full information about the organisation of telephone exchanges in this country, but also full details of those in the United States, which are admittedly ahead of any in this country. According to evidence quoted by Mr. Kingsbury, it is not an uncommon thing for an operator to make 200 connections per hour—that is to say, she will answer the call, get the person called for, and put them together. As many as 222 connections have been counted. Whether a similar speed has ever been attained in this country does not appear to be stated. At all events, it is a record of a remarkable fact, and illustrates the female capacity for endurance.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m. :—

January 26.—J. Arthur Hutton, Chairman of the British Cotton-Growing Association, "The Effect of the War on Cotton-Growing in the British Empire." Sir Daniel Morris, K.C.M.G., D.C.L., D.Sc., will preside.

February 2. — The Hon. Lady Parsons, "Women's Work during and after the War." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

February 9.—Professor J. A. Fleming, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

February 16. — S. Charles Phillips, M.S.C.I., "Paper Supplies as affected by the War." Lord Burnham will preside.

February 23.—Miss H. B. Hanson, M.D., B.S., D.P.H., "Serbia as seen by a Red Cross Worker."

March 1.—Charles Delchevalerie, "Belgian Literature."

March 8.—Charles R. Darling, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

Indian Section.

February 17.—C. A. Kincaid, C.V.O., Indian Civil Service (author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.), "The Saints of Pandharpur: the Dawn of the Maratha Power." Lieut.-Colonel Sir David W. K. Barr, K.C.S.I., will preside.

March 16.—Professor Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

Dates to be hereafter announced :—

R. W. Seton-Watson, D.Litt., "The Balkan Problem."

Rev. P. H. Ditchfield, "The England of Shakespeare."

W. A. Craigie, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

Victor Horta, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

Professor T. G. Masaryk, "The Slavonic Peoples."

G. P. Baker, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

Edward Percy Stebbing, F.L.S., F.R.G.S., Head of the Department of Forestry, University of Edinburgh, "Forestry and the War."

Sir Daniel Morris, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

James MacKenna, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

Indian Section.

Thursday afternoons at 4.30 p.m. :—

April 6, May 18.

Colonial Section.

Tuesday afternoons, at 4.30 p.m. :—

February 1, March 7, May 2.

Cantor Lectures.

Monday afternoons at 4.30 p.m. :—

J. Erskine-Murray, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

Fothergill Lectures.

Monday afternoons, at 4.30 p.m. :—

Rev. Dr. Herbert West, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "National and Historic Buildings

in the War Zone: their Beauty and their Ruin." Three Lectures.

Syllabus.

LECTURE I.—FEBRUARY 7.—*Belgian Architecture and History.* Belgium a land of cities—What makes a city (Gen. xi. 4)—Tower—Church—Communal Hall—Belgian civil architecture, commercial —Cloth Halls before Town Halls—Churches borrowed, but splendid furniture given by Trade Guilds. Ypres typical — Tournai. Rhenish. Source of Noyon—Soissons. St. Remi—French efforts to annex Flanders—The Matins of Bruges —Battle of the Spurs. Courtrai—Rivalry of Ghent and Bruges—Edward III. and J. van Artevelde—Sluys—Coucy. Pierrefonds—Mediæval sieges—Philip van Artevelde, Roosebek. Suzerainty of Burgundy—Charles the Rash and Louis XI. Dinant—Sack of Liége. Mary of Burgundy. Arras—Lierre. Charles V. and Philip II. Egmont and Horn—Louvain—Malines—Antwerp—Louis XIV. and William III. Namur. Bombardment of Brussels.

LECTURE II.—FEBRUARY 14.—*Gothic Architecture, French and English.* The French Cathedral, a Great Hall, the centre of the city's life. The English Cathedral a Monastic Missionary settlement, independent of the city. The problem of Mediæval Architecture, to reproduce Roman vaulting—Solved by permanent stone centrings (diagonal ribs) under the intersections of a groined vault (Vezelay, Durham, St. Denis, Sens). Buttresses necessary (Chartres, Amiens, Beauvais). The walls become screens of glass. Inside—Columns replaced by vaulting ribs running down to the ground (Notre Dame—N. D. de l'Épine, Abbeville). Contrast of French and English plans (Notre Dame and Salisbury). In the English Cathedral, horizontal, not vertical perspective sought. Beauty of clustered columns. Purbeck causes deep mouldings. Multiplication of vaulting ribs. Lierne and fan vaulting—Flamboyant and perpendicular—English and French façades—The French Cathedral is the expression of the National ideal; the English, of the National history.

LECTURE III.—FEBRUARY 21.—*French Mediæval Sculpture.* Christian art that of a new-born society rising amidst a dying civilisation—Provençal sculpture, Arles, etc., decadent—Burgundian, full of life and imagination; but Classical influence traceable all through (Vezelay, Autun, Auxerre)—XIIth Century (Avallon, Bourges, N. and S. doors, Chartres, W. front). Elongation of statues, architectural not ignorant—Individual types, elaborate detail. The sculpture scheme of a XIIIth Century cathedral (Laon, Notre Dame, Amiens, Reims). The Judgment door (Autun, Notre Dame, Amiens, Rampillon, Reims, St. Maclou)—The Virgin's door—Local Saints and legends (St. John Baptist, Rouen; St. Stephen, St. Théophile, Paris; St. Thomas, Semur; St. Nicaise, Reims)—The Arts, Virtues and Vices—The Months and Daily Life (Paris, Amiens, Rouen)—Statuary (St. Stephen, Sens—The Virgin, Paris—Chartres, N. and S. porches)—Reims, W. portals—Figures of Christ (Chartres, Amiens, Reims, Troyes, Solesmes).

The lectures will be illustrated by lantern-slides.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 24...Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. W. J. Malden, "Labour-saving Implements and Machinery."

East India Association, Caxton Hall, Westminster, S.W., 4.15 p.m. Lady Muir-Mackenzie, "Indian Women and National Well-being."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Professor J. W. Gregory, "Cyrenaica."

TUESDAY, JANUARY 25...Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "The Physiology of Anger and Fear." (Lecture II.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Discussion on Mr. F. W. Carter's paper, "The Electric Locomotive."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Dr. C. A. Swan, "Round the Mediterranean and the Near East."

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 4 p.m.

Electrical Engineers, Institution of (Local Section), 17, Albert-square, Manchester, 7.30 p.m. Paper on "Printing Telegraphs."

WEDNESDAY, JANUARY 26...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. J. A. Hutton, "The Effect of the War on Cotton-Growing in the British Empire."

University of London, King's College, Strand, W.C., 5.15 p.m. Professor F. J. C. Hearnshaw, "The War and the Baltic."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5 p.m. Mr. A. C. Benson, "The Letters of Mary Sibylla Holland."

THURSDAY, JANUARY 27...Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. A. Bone, "The Utilisation of Energy from Coal: Fuel Economy from a National Standpoint." (Lecture II.)

China Society, Caxton Hall, Westminster, S.W., 3.30 p.m. Mr. S. G. Cheng, "The Chinese as a Warrior in the Light of History."

FRIDAY, JANUARY 28...Royal Institution, Albemarle-street, W., 5.30 p.m. Dr. L. Hill, "The Science of Clothing and the Prevention of Trench Feet."

Physical Society, Imperial College of Science, South Kensington, S.W. (Guthrie Lecture.) Mr. W. B. Hardy, "Some Problems of Living Matter."

Engineers and Shipbuilders, North-East Coast Institution of, Newcastle-on-Tyne, 7.30 p.m.

SATURDAY, JANUARY 29...Royal Institution, Albemarle-street, W., 3 p.m. Mr. C. J. Holmes, "Raphael and Michelangelo." (Lecture II.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, FEBRUARY 2nd, 4.30 p.m. (Ordinary Meeting.) THE HON. LADY PARSONS, "Women's Work during and after the War." DUGALD CLERK, D.Sc., F.R.S., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

PRESENTATION OF THE ALBERT MEDAL TO PROFESSOR SIR JOSEPH JOHN THOMSON.

At the last meeting of the Council, on Monday afternoon, the 24th inst., Dr. Dugald Clerk, F.R.S., Chairman of the Council, on behalf of H.R.H. the Duke of Connaught and Strathearn, K.G., President of the Society, presented the Society's Albert Medal to Professor Sir Joseph John Thomson, O.M., D.Sc., LL.D., F.R.S., "for his researches in physics and chemistry, and their application to the advancement of Arts, Manufactures, and Commerce."

In making the presentation, Dr. Clerk said :—

"Sir J. J. Thomson is the successor of Clerk-Maxwell, in that he deduced the physical consequences of Clerk-Maxwell's electro-magnetic theory and studied the numerous phenomena of high-frequency electric oscillations. His many investigations on these matters have proved of the greatest value to the electricians who developed the practice of modern wireless telegraphy. Among his important contributions to such knowledge may be mentioned his discovery of the change in the dielectric strength of the atmosphere and other bodies for high-frequency oscillations, also the variations with changing atmospheric density.

"His more abstract work on the atom and molecule is equally useful in that it renders possible a reasonable theory of the nature of matter and gravitation. Newton discovered the law of gravitational attraction; it remained for Sir J. J. Thomson to throw light upon the various theories of this most mysterious of phenomena.

"His brilliant work has also industrial possibilities in the region of motive power; but altogether apart from this, the new knowledge of the nature of the atom and molecule mark an epoch of intellectual advance of the highest importance to mankind."

In addition to the Chairman, the following members of the Council were present:— Sir Steuart Colvin Bayley, G.C.S.I., C.I.E. (Vice-President), Alan S. Cole, C.B., William Henry Davison, M.A. (Treasurer). Sir Steyning William Edgerley, K.C.S.I., K.C.V.O., C.I.E., Peter Macintyre Evans, M.A., Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc. (Vice-President), Major Percy A. MacMahon, R.A., LL.D., D.Sc., F.R.S., Hon. Richard Clere Parsons, M.A., Sir Robert W. Perks, Bt., Sir Boverton Redwood, Bt., D.Sc., F.R.S.E., Lord Sanderson, G.C.B., K.C.M.G. (Vice-President), John Slater, F.R.I.B.A., Alan A. Campbell Swinton, F.R.S., and Professor J. M. Thomson, LL.D., F.R.S. (Vice-President).

COVERS FOR JOURNALS.

For the convenience of Fellows wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s.* 6*d.* each, on application to the Secretary.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

SEVENTH ORDINARY MEETING.

Wednesday, January 26th, 1916; SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Bird, Captain Clarence A., R.E., 42, Fordhook-avenue, Ealing Common, W.

Crowther, Charles, 63, Yamamoto-dori 4 Chome, Kobe, Japan.

The following candidates were balloted for and duly elected Fellows of the Society:—

Haddon, Walter, 132, Salisbury-square, E.C.

Henderson, Lucius J., 10, Fauenil-place, New Rochelle, New York, U.S.A.

Howell, Hon. Clark, Atlanta, Georgia, U.S.A.

Lal, Lala Mohan, B.A., Gulshan Villa, Simla, India.

Phillips, J. S. M., Merchant's Bank, Pittsburgh, Pennsylvania, U.S.A.

Robbins, Rowland Richard, J.P., Holly Croft, Sipson, Middlesex.

Wooldridge, Charles L., Fulton Building, Pittsburgh, Pennsylvania, U.S.A.

The paper read was—

THE EFFECTS OF THE WAR ON COTTON-GROWING IN THE BRITISH EMPIRE.

By J. ARTHUR HUTTON,
Chairman of the Council of the British Cotton-Growing Association.

There could hardly be a more appropriate time for considering how the industry of cotton-growing, which has been established in new fields within the Empire, has been affected by the war, and also, which is perhaps more important, what are the prospects for the future. An immense amount of time, energy and money has been devoted to the cause during the last dozen years, and it would be a calamity if all these efforts were to be wasted and if this new industry were to disappear entirely, or even to come to a standstill. Before, however, considering this problem, I propose, for the benefit of those who are not acquainted with the details of our work, to give a short account of the causes which led to the formation of the British Cotton-Growing Association, and of the work which we have so far been able to carry out.

THE ORIGIN OF THE MOVEMENT.

During the five years ending in 1895 the cotton crop of the United States averaged about 8,300,000 bales—with fluctuations between 7½ and 10 million bales. In the following five years the average production rose to about 9,500,000 bales, with a minimum of 7 and a maximum of 11¼ million bales. This increase of 1,200,000 bales was, however, accompanied by increased consumption in America and more particularly in the Southern States. The consumption rose from 2,600,000 to 3,200,000 bales, so that the States themselves used up fully half of the increased production, and whereas they formerly used 31 per cent. of the total crop, their consumption rose to 34 per cent. The result was that there was some considerable shortage in the available supply of the raw material for the rest of the world. In the year 1900 the total crop amounted to only 9,422,000 bales, with the consequence that many of the mills in Lancashire had to run short time. I need hardly dwell on the sufferings which were caused, and the monetary losses which followed; but I must insist on this point, that in difficulties of this sort labour always suffers more than capital. Spinners, manufacturers, and merchants can frequently make up previous losses when prosperous times again return, but time once lost by the operatives is gone for ever.

In January 1901, at the annual dinner of the Oldham Chamber of Commerce, Mr. Benjamin Crapper, who is one of the most active members of our Council, drew attention to the dangerous position of the Lancashire cotton industry, owing to the fact that it was dependent on the United States for the bulk of its supplies of the raw material, and therefore was at the mercy of the vagaries of the weather in one particular part of the world. He also drew attention to the obvious fact that the only way in which the calamity of a short crop could be avoided in the future was by the establishment of cotton-growing in all parts of the world. If the basis of supply could be broadened, and if cotton could be grown in quantity in Africa and other countries as well as in India, Egypt and the United States, one could regard with comparative equanimity the failure of the crop in any particular country, for in all probability this would be counterbalanced by more favourable climatic conditions elsewhere. If this could be done successfully the market would no longer be at the mercy of ruthless speculators, who, whenever the conditions were favourable,

would "corner" the market and force prices up as much as possible, regardless of the sufferings they might inflict on the hard-working operatives. We all realise that a shortage of wheat and dear bread is a calamity for the working-classes, and more especially for those who have a difficulty in making both ends meet. It is, perhaps, not so generally realised that to Lancashire, and indeed to the cotton trade of the whole world, cotton is equally important. It is a common saying that cotton is Lancashire's "bread and butter." I should also point out that many other people are also seriously affected, for cotton is the cheapest of all textile materials, and the poorest people in the world use no other clothing than cotton. If, therefore, the price of cotton rises in consequence of short supplies they suffer accordingly.

While dealing with this point, I must draw particular attention to the question of quality. The Lancashire cotton trade is mainly an export trade, and therefore has to meet the competition of the whole world, and there is probably no industry which has suffered more through hostile tariffs. So far, this competition has been mainly met by producing articles of finer and more superior quality, which were beyond the capabilities of our competitors. The production of such articles required not only greater skill on the part of the operatives, but also longer, finer and better qualities of cotton. India, which produces about 5,000,000 bales, seems to be unable to grow the quality of cotton required. Out of a total consumption of 4,000,000 bales Lancashire only uses about 200,000 bales of Indian cotton, and these solely for the coarsest cloths. Owing to the attacks of the boll-weevil the States are also unable to produce sufficient quantities of long-stapled cotton. The only other country which can produce the quality required is Egypt, but the total annual production of this country is less than a million bales, and unfortunately the cultivable land is limited in quantity and no large increase in production can be expected in the future. The problem, therefore, was not only how to establish and develop new cotton-fields, but also to discover countries where cotton of good and suitable quality could be grown.

Preliminary Inquiries.

With the characteristic thoroughness of Lancashire, the Oldham Chamber of Commerce promptly followed up Mr. Crapper's speech by appointing a committee to inquire into the whole question. A considerable amount of correspondence took place with the Colonial Office, governors, and other colonial officials, with the object of ascertaining what were the possibilities of establishing new cotton-fields in the British Empire. This report was published in November 1901, and may be summarised in one sentence. In the opinion of the committee: "Suitable cotton for the Lancashire trade could be grown in various parts of the British Empire."

The Formation of the Association.

The report was circulated amongst the other Chambers of Commerce, and a copy was sent to the Manchester Chamber, of which I was then a Director. It struck me that there might be great possibilities in West Africa in which I was particularly interested. I got into communication with the late Sir Alfred Jones and also with Mr. J. E. Newton, the President of the Oldham Chamber of Commerce. It is always difficult to get a large number of commercial men together during the daytime, so I invited Sir Alfred Jones and some of the principal West African merchants to dinner on May 7th, 1902, to meet Mr. Newton and other representatives of the manufacturing trade. At that dinner the British Cotton-Growing Association was born.

A general meeting of various associations and representative men was held in Manchester on June 12th 1902, when the Association was formally inaugurated with a guarantee fund of £50,000. Sir Alfred Jones was the first President of the Association, and I should like to take this opportunity of again expressing the immense debt of gratitude owed to his memory by all who are interested in the welfare of the British Empire. It is largely due to his untiring enthusiasm and energy and also to his splendid generosity that the Association has attained its present position. After his death the Earl of Derby very kindly consented to accept the position of President, and I have no hesitation in saying that it would be impossible to find anyone more capable of acting as President of the Association, or who would have devoted more of his valuable time to the work.

The Committee at once set to work, and several cotton experts were immediately sent out to inquire and report with a view to undertaking more active operations. It was soon found that the work the Association had undertaken was very much larger than was originally contemplated, and the Committee began to realise that for a number of years a vast amount of

pioneering work would have to be carried out, and that as this work could not be remunerative at first it would be difficult, if not impossible, to get ordinary capitalists to interest themselves. Consequently, the Association were compelled to commence direct operations, and in November, 1903, the guarantee fund was raised to £100,000.

In January, 1904, owing to another shortage in the supply of American cotton, the situation in Lancashire became so much more serious that it was decided to reconstitute the Association on a more permanent basis and to apply to his Majesty, the late King Edward, for a Royal charter. On August 27th the charter was finally sealed, and shortly afterwards the Association was reconstituted on its present basis with a capital of £500,000, of which £480,000 has been actually subscribed.

I think it is very much to the credit of Lancashire that this large sum of money should be raised solely for the purpose of extending the growth of cotton throughout the British Empire, and without any hope of payment of dividends for many years to come. It is also much to their credit that so many members of the Council have given up valuable time for the good of the cause. It is always much easier for a business man to give money than time, especially so when the time is given without any monetary reward. The strength of the Association is, however, mainly due to its representative character. Its members consist of spinners and manufacturers, merchants and shippers, bankers, insurance companies, shipowners and representatives of all the various industries connected with the cotton trade. What is perhaps more important is the fact that in this great movement capital and labour are co-operating together, and some of the most valuable members we have on the Council are the representatives of the labour associations, while a large amount of our capital has been provided by labour. The late Mr. Joseph Chamberlain urged that England should be taught "to think Imperially." I think we can fairly claim to have even done better than this, and that we are "acting Imperially," for we have started a movement which will have the most beneficial effect on the Empire, and which will, if successful, bring prosperity not only to Lancashire but also to all parts of the British Empire where cotton can be grown. In the words of Mr. Winston Churchill, "cotton is the thread which unites the interests of the industrial democracy with the development of our great possessions across the seas."

Government Assistance.

In view of the representative nature of the Association and of the Imperial objects of their work, the Council had every confidence in appealing to the Government for assistance, and it is a pleasure to be able to state that, no matter which party was in power, the Government have responded both willingly and generously to our representations. It would be invidious to mention individuals, and, indeed, it would take too much time to record the names of all who have helped us in our great work. Prime Ministers, Cabinet Ministers, members of Parliament, colonial governors, colonial officials, and last, but by no means least, colonial directors of agriculture, have all willingly given us valuable help and sympathy. In addition, we have received a considerable amount of financial assistance from the West African colonies, and since 1908 we have received a grant of £10,000 per annum from Imperial Funds. I should, however, point out that this grant is given for specific services, and the amount spent by the Association on these services has always been considerably in excess of the sum received from the Government.

In addition to direct assistance, very great help has been given by the Government in the construction of railways, roads, and harbour works, but naturally all trades benefit by any improvement of transport facilities. As I have often said, there is no better investment of Government money than the construction of railroads in Africa, for it is almost impossible to make a railway in Africa which will not pay. Even that once much-maligned Uganda railway is to-day a financial success, though this is almost entirely due to the development of cotton-growing. Apart altogether from the benefit to cotton-growing and to other trades, all these railways result in large economies in the cost of administration, and every colonial government must benefit from the greatly-increased revenue which naturally follows the increase in trade. The Association, therefore, in urging the Government to construct railways were at the same time giving them sound business advice. The Association are, however, more than grateful for the assistance they have received, and the Council confidently expect that this assistance and co-operation will be continued in the future.

The Work of the Association.

In dealing with the work of the Association, it would take too long to do more than mention the experiments and inquiries which were spread over many parts of the world. They extended

over a large area—India, East, West, and South Africa, the West Indies, Australasia, and elsewhere—in fact, there was hardly a part of the British Empire, where the conditions offered any prospect of success, with which we were not in communication at one time or another during the first five years of our work. As an illustration, I may mention that Malta, Cyprus, Mauritius, and the Fiji Islands were included in our investigations.

When practical work was commenced, we had no technical knowledge of the question, and what added to our difficulties was the fact that there was no one in this country who could give us any definite information or advice, and we had to discover everything for ourselves, with the consequence that some mistakes were made. In the colonies the departments of agriculture were either non-existent or had very little practical knowledge of cotton-growing. The one brilliant exception was the Imperial Department of Agriculture in the West Indies, which was, I believe, formed by the late Mr. Joseph Chamberlain. It is an astounding fact that, although our tropical and sub-tropical possessions are almost entirely dependent on agriculture for their prosperity, the Government had prior to 1900 absolutely neglected the scientific development of agriculture, and such departments as did exist were understaffed and underpaid. Since then, and largely in consequence of frequent representations from the Association, something has been done to put matters right; but I am sorry to say that in most of our colonies the Department of Agriculture is still the "Cinderella" of the establishment.

Amongst other suggestions we strongly urged the formation of a central bureau in London, if it was only for the collection and collation of information, so that one colony could profit by the experience gained elsewhere. The authorities yielded so far to the repeated representations of the Association as to appoint a small scientific committee, but so far I have never heard of its even being called together.

There is one point I must mention in connection with those of our experiments which have been unsuccessful. We have never been afraid of owning up to any mistake we have made. If we found in any particular venture that the results were not likely to justify the expenditure of time and money, as sensible business men we have closed down our work without hesitation and have cut our losses. On the other hand, even when an experiment was not giving immediate satisfactory results, if we thought there were future prospects of success we have continued our work in spite of current losses.

As the work developed, we soon found that it was essential that we should concentrate our efforts on those districts which offered the best prospects of success in the immediate future. We therefore decided to close down our work in those districts where large developments could scarcely ever be expected even under most favourable circumstances, or where, owing to lack of transport, economic progress was for the present out of the question. The main districts where we decided to push on the work were as follows: India, the West Indies, West Africa, Uganda and East Africa, Nyasaland, and the Anglo-Egyptian Sudan. I now propose to deal as briefly as possible with our work in each of these centres.

India.

There are enormous possibilities in India, and the present production is already very large, ranging from 4 to 6 million bales per annum. Unfortunately, as I mentioned before, the quality is unsuitable for anything but the coarsest yarns, and not one Lancashire spinner in a hundred could make any use of Indian cotton. In illustration of this point I should mention that during the great cotton famine it was no uncommon thing for meetings to be held to pray for supplies of cotton. At a meeting held in Stockport, it is related that in the middle of the prayers a voice broke in: "Yea, Lord, but please not Surats." As regards India, therefore, the main efforts of the Association were devoted to the question of improvement of quality; and in 1904 very urgent representations were made to the Secretary of State and to the Viceroy, for it was felt that the Government of India were the only body who could do any good. The main point on which the Association insisted was that, if India could produce a superior type of cotton, the grower would be able to command a wider market and a higher price for his produce. In addition, it was strongly urged that the Department of Agriculture should be strengthened by the appointment of experts who had a scientific knowledge of agriculture, and who were acquainted with the best modern methods pursued in the United States and Egypt.

The Association did not confine itself to representations and advice, but spent over £3,000 in endeavouring to establish perennial, or tree-cotton. I regret to say this experiment was unsuccessful. In 1905 the Council voted a

further sum of £10,000 to be spent by the Government of India in experimental work. Of this amount the sum of £2,000 was actually spent, but afterwards, in view of the heavy demands on the Association in other colonies, the Government agreed that the Association should be relieved of further liability in the matter. Later on the Association made another practical attempt to encourage the growth of superior cotton by offering to establish buying stations and ginning and baling factories, and to supply the best qualities of seed, and to pay the natives the highest possible price for their cotton. The Council, however, stipulated that the Government should take half the risk, and share either the profit or the loss, as the case might be. In consequence of representations from Bombay spinners and manufacturers, which, I have heard it suggested, were perhaps not altogether disinterested, the Indian Government were unable to accept the Association's offer, which would certainly have ensured a better selection of seed and that the native farmer was properly rewarded for his labour. Later on the Government entered into arrangements with the International Federation of Cotton Spinners to carry out some experiments on similar lines. Owing to the war the concession granted had to be cancelled, and the Government then invited the Association to take up the work. Unfortunately the Association were no longer in a position to provide the necessary capital, owing to increasing demands in other fields, and they were reluctantly compelled to refuse this offer.

Although the Association are no longer carrying on any direct operations in India, they are rendering very valuable assistance to the Government by reporting on samples of new types of cotton. Owing to their close connection with the Lancashire trade, both with spinners and brokers, they are in a particularly favourable position to judge as to the suitability for the market of any new type of cotton. When all is said and done, the buyer has the last word in the matter, and if the farmer is to obtain a good price for his cotton it is essential that he should grow the quality which the spinner requires. It is also of immense advantage to the Government to have at their disposal expert assistance and advice, which is at the same time absolutely disinterested.

West Indies.

In some ways our task in the West Indies was easier than elsewhere, for we had the invaluable assistance of expert agriculturists who had been scientifically trained. I refer, of course, to the very able Director and staff at the Imperial Department of Agriculture, who have done such splendid work for the West Indian Islands. It would be a good thing for the colonies, and, indeed, for the whole Empire, if such an organisation existed in every one of our tropical possessions. As might be expected, with this expert assistance our efforts in the West Indies have been eminently successful, and these islands are now producing a sufficient quantity of Sea Island cotton to meet the present demand.

The Association have made several money grants to the West Indies for the payment of experts, the erection of ginning machinery, and providing improved seed. What, however, has probably been of even more assistance, was arranging for members of the Association to visit the islands, when they were able to get into close touch with the planters and to impress on them the necessity of producing the quality of cotton required by the spinner. No less than three separate visits have been paid to the West Indies, and it is largely due to this that these islands are now producing the finest Sea Island cotton grown in the world.

The principal assistance now rendered by the Association is in financing and marketing the crop, and I am glad to say that very little money has been lost in this direction. Undoubtedly one of the principal reasons for the success of the British trader is our national honesty, and we have not had a single instance of our confidence having been taken advantage of in the West Indies.

An immense amount of time and trouble is devoted to the sale of the cotton so as to ensure that the grower will receive the highest possible price. Sea Island cotton is not everybody's cotton, and it is by no means an easy matter to place it to the best advantage. The Association, however, recognise that they are in the position of trustees, and that it is their duty to do their best for any cotton confided to their care—though in any case it would be to their interest to obtain for the planter the highest possible price, for this is naturally the best method of encouraging the planter to continue and extend the industry.

I am glad to say that the planters fully recognise the advantages offered them, and the bulk of the crop is consigned to us for sale.

West Africa.

Notwithstanding the great amount of time and money devoted to West Africa, the results have not been so successful as could be wished. There is an immense area of land available and a large population, but there are many competing products, and it is only reasonable that the native should devote his principal energies to the crop which pays him best, or which he thinks will pay him best. The Council very soon discovered that in West Africa, and one might say in almost all tropical countries, cotton is essentially a black man's crop. Plantations managed by Europeans on which the natives work as hirelings have been a conspicuous failure in West Africa, and there seems to be little doubt that the native will do better when working on his own account than when working for wages. For this reason the main efforts of the Association had to be devoted to encouraging and helping the native to grow cotton. This would, under any circumstances, mean slow progress, and the progress has been slower than was hoped for, owing to the difficulty of establishing a variety of cotton which would give the native a better return for his labour. The general quality of West African cotton is not high, and therefore cannot command a big price.

Owing to the absence of any properly-equipped agricultural departments, the Association undertook the expensive experimental work of seed farms, but in 1910 this branch was transferred to the governments, and everything had to be commenced *de novo*. It takes fully five years to establish any new variety of cotton sufficiently to justify one in distributing the seed to the natives. The consequence is that the prospects of producing cotton of superior quality are now infinitely brighter. This loss of time is to be regretted, but it is solely due to the fact that when the Association commenced their work there were no properly-equipped departments of agriculture in West Africa.

Ultimately the work must be placed upon a purely commercial basis, and therefore during recent years the Association have given particular attention to what I may term the commercial side of the question. Ginning and baling factories have been erected and buying centres established, and the necessary funds provided for financing and handling the crop. The Association have, I am glad to say, received invaluable assistance from the merchants established in West Africa. The buying price is fixed by the Association, and the merchants receive a fair commission for their services. In fixing the buying price the Association have adopted the policy of paying the highest possible price which the conditions of the market would allow, for they fully recognise that if the industry is to make any progress it must be remunerative to the native. This has been the policy of the Association, not only in West Africa, but also in all other colonies where they are established. In proof of this I should mention that, as a rule, the Association's cotton-buying account shows that we just about cover expenses.

The work in Gambia was a failure, as the natives preferred their old industry of growing ground-nuts. In Sierra Leone the rainfall was too heavy for cotton to be a success. In both these colonies the work was closed down some years ago. The Association is now giving up its work in the Gold Coast, because in those districts where there are good transport facilities cocoa is more profitable than cotton, and in the interior the results have not been sufficiently satisfactory to justify the expenditure of more time and trouble. This also applies to the Eastern Province of Southern Nigeria. The best results, so far, have been obtained in Lagos, and in 1913 and 1914 the crops amounted to 14,000 and 13,600 bales respectively. Unfortunately in 1915 the climatic conditions were unfavourable, and it is not expected that the crop will exceed 7,000 bales. In Nigeria, where the conditions are most favourable, very large quantities of cotton are produced every year, but owing to the demand for local consumption the ruling price is generally above the basis of the Liverpool market. The maximum quantity purchased in any one year by the Association was 2,600 bales in 1912. I should mention that the Association provide the Agricultural Departments with the seed required each year for sowing free of charge.

Nyasaland.

In Nyasaland the industry was originally commenced by white planters, and the Association did all that was possible to encourage the growth of cotton by making advances against growing crops. Notwithstanding all possible care, a considerable sum was lost in this manner, and as some of the planters commenced growing tobacco instead of cotton, it was decided to direct more attention to the possibilities of establishing cotton-growing as a native industry. The results have been in every way satisfactory, and in spite of serious transport difficulties and occasional unfavourable climatic conditions, cotton-growing is now

firmly established in Nyasaland as a native industry. The Council are convinced that, although it means slower progress at first, in the long run the largest results will be obtained when the industry depends principally on native farmers working on their own account.

The Association have erected four ginning factories in Nyasaland, they have opened up a number of buying centres, and are acting in the closest co-operation with the Government and the Agricultural Department. The Association also provide, free of charge, all the seed that is required for distribution amongst the natives.

The one great disadvantage in Nyasaland is the great difficulty of transport, and when it was decided to extend the Shire Highlands railway from Port Herald to Chindio, so as to bring the colony into economic touch with the Zambesi River, the Association and their friends raised £36,200 of the required capital.

Uganda.

In Uganda the work of the Association was not carried on directly, but through the medium of the British East Africa Corporation. This arrangement has been terminated recently, and the Association is now conducting direct operations. Although the Association did not at first undertake any direct work, except through the Corporation, they were in constant communication with the Colonial Office and with the local authorities on the various problems which were continually arising in connection with the industry.

In Uganda cotton-growing is purely a native industry, and thanks to a fertile soil, favourable climatic conditions, a large and intelligent population, coupled with an excellent form of native government and good transport facilities, the industry has progressed most rapidly. In the early days there was no efficient Department of Agriculture, and large quantities of seed of various varieties were distributed indiscriminately, and in any one shipment from Uganda one could find cotton of every variety and nature mixed together. Mainly in consequence of the efforts of the Association, this has now been put right, and under the able administration of the Department of Agriculture, Uganda cotton is improving in quality, and is acquiring a well-deserved reputation in the Liverpool market.

This is a very good example, where the industry depends solely on the natives, of the necessity of the distribution of seed being placed under strict Government control, or in the hands of an impartial body like the Association. If the supply of seed depends on irresponsible individuals, mixture and deterioration are bound to occur. This is the most vital question in connection with cotton-growing, for unless the seed issued to the natives is sound in quality and pure in strain everything else is thrown away. One may have the most perfect climate and the most excellent soil in the world, and the best methods of cultivation; but unless the seed sown is of good quality all these advantages are utterly wasted.

In addition to representations to the Government in connection with the quality of seed, transport difficulties and other various problems, the Association rendered most valuable assistance in the form of very large loans to the British East Africa Corporation. The money lent was utilised for the erection of ginning and baling factories, and for the purchase of cotton. It is perhaps not generally realised how large an amount of actual cash is required for moving a cotton crop. Even under favourable conditions some considerable time must elapse between the date when the cotton is bought and when actual shipment takes place. Afterwards, when bills of lading and documents are available, finance is easier to arrange, though, owing to the delays in selling any cotton which has not acquired a recognised status on the market, bankers are not always so ready to provide the necessary finance, except with ample margin or on onerous terms.

The Association have rendered invaluable assistance in this direction, for owing to their position they are able to obtain exceptional facilities from bankers, and the Council have always made a point of giving their customers the benefit of the favourable terms which are granted to the Association. It is no infrequent occurrence for the Association to have out on loan against cotton and machinery well over £500,000.

The first record of exports of cotton from Uganda was in 1904, when fifty-four bales were shipped. In 1908 the shipments amounted to 4,000 bales, and in 1911 there was a further increase to 20,000 bales. In 1914 it was estimated that the crop was over 40,000 bales, which, together with the seed, would represent a money value of close on £500,000. When one considers that twelve years ago cotton-growing was non-existent in Uganda, it will be generally admitted that this is a wonderful result to have achieved in so short a time.

ANGLO-EGYPTIAN SUDAN.

It is only in recent years that cotton-growing on a large scale has been possible in the Anglo-Egyptian Sudan. Prior to the completion of the Suakin-Berber Railway in 1906 the only district where cotton was grown for export was at Tokar on the Red Sea. Thanks to careful management on the part of the Government, Tokar is now annually producing about 8,000 bales of cotton of very fair quality, but as the crop depends on a rather uncertain supply of irrigation water, coupled with very irregular rains, there is considerable variation both in the quantity and quality of the cotton.

When the railway was completed the Association offered their services, but were informed that their help was not required, and no further steps were taken in the matter.

In 1910 the Council were approached by the Sudan Plantations Syndicate, who invited their co-operation in pushing on the cultivation of cotton, with the result that the Council took a large financial interest in this company, and I was appointed to the board to represent the Association's interests. The Council were so impressed with the possibilities of the country that they arranged for a special deputation to visit the Sudan in 1912, and since then we have done all in our power to assist in the development of the industry.

It would take too long to describe in detail the possibilities of this wonderful country, but I should mention that there are five distinct and separate propositions as follows :—

(1) *Tokar.*—Good possibilities of producing 10,000 to 20,000 bales in the immediate future.

(2) *Khartoum and North.*—Fair prospects for 5,000 bales or more of good quality of Egyptian cotton with further possibilities in the future.

(3) *Gezira.*—One of the finest cotton propositions in the world. There are possibilities of raising 50,000 bales of high-class Egyptian cotton in the immediate future, and there is no reason why the production should not be increased to 250,000 bales or more within the next ten to fifteen years, with ultimate possibilities of an annual production of more than 1,000,000 bales. As I stated before, the Egyptian crop is less than a million bales.

(4) *Rain-grown Cotton.*—This is a proposition for the future, but there is land enough to grow millions of bales.

(5) *Gedaref and Kassala.*—Here there are also fair possibilities of producing considerable quantities of both rain-grown and irrigated cotton.

The Association have rendered most valuable assistance in financing and marketing the cotton, and so ensuring that the native should receive the best possible price for his crop. Their main efforts have, however, been devoted to educating both the country and the Government as to the great possibilities of the Sudan, and they insisted on the fact that it was the duty of this country to provide financial help to the Sudan Government. These efforts culminated in a deputation to Mr. Asquith on January 23rd, 1913, when they received a promise that the Government would guarantee the interest on a loan of £3,000,000 to be raised by the Sudan Government for the construction of irrigation and other works in the Sudan. Unfortunately, before matters were sufficiently advanced to justify the issue of the loan, war broke out and everything had to be postponed. In the meantime two experimental pumping stations have been established and are in full working order. The results obtained have been most satisfactory and are most promising for the future.

I should mention that a most interesting Socialistic experiment has been inaugurated at these two stations. Lord Kitchener was, I understand, much disturbed by the fact that in Egypt the cultivator on whom the brunt of the work falls only receives a very small proportion of the proceeds of his crop as a reward for his arduous labours. He was determined that in the Sudan the farmers should not be left at the mercy of capitalists, and I understand that he himself drew up the proposals which have since been adopted. The scheme is shortly as follows : The total proceeds of the crop are pooled together and divided into shares. The Government provide the land and the water and receive 35 per cent. of the total. The syndicate who look after the financing, direction and management receive 25 per cent., leaving 40 per cent. for the farmer as the reward for his time and labour.

Lord Kitchener is much to be congratulated on the boldness and simplicity of this scheme, which will, at any rate, ensure that the man who actually grows the crop will be able to obtain a fair reward for his labours, which is, unfortunately, not always the case in many parts of the world.

Before leaving this point I should like again to draw attention to the fact which I previously mentioned, that Lancashire urgently requires increased supplies of cotton of superior quality. It is becoming more and more difficult to obtain cotton of suitable quality for fine yarns, and this is clearly shown in the price of Egyptian cotton.

In the five years ending in 1915 the American crop averaged 14,400,000 bales, as compared with 8,300,000 bales in the five years ending in 1895, an increase of 6,100,000 bales, but the average price has increased from 4¼*d.* to over 6½*d.* If we eliminate 1915, when the price was unduly depressed owing to the war, the average would be over 7*d.* per lb., giving an increase in twenty years of 1¾*d.* per lb. During the same period the Egyptian crop has increased from an average of about 900,000 to 1,500,000 bales of 500 lb., an increase of only 600,000 bales in twenty years, but the average price has increased from 5¾*d.* to 10½*d.*, a difference of no less than 4¾*d.* per lb. This means that whereas twenty years ago Egyptian cotton commanded a premium of only 1*d.* per lb. over American, the average premium to-day is over 3*d.* per lb. This increase in premium is almost entirely due to the growing demand for, and the consequent scarcity of, long-staple cotton. One therefore cannot resist the conclusion that it is the duty of the Government, and, of course, of the Association, to do all that is possible to develop every district capable of growing high-class cotton, for it is no exaggeration to state that on the success of these efforts depends the whole future—indeed, the very existence—of the Lancashire cotton industry.

Commercial and Other Work.

Before I conclude this summary of the work of the Association I must draw attention to what I may term the commercial side of our work. We do all we can to help planters and others by making advances against crops and by financing the cotton after it is gathered, and our charges are made as light as possible. Further, we accept risks which would not be undertaken by ordinary commercial firms. We look after shipment, pay the freight, see that the cotton is properly insured, and afterwards superintend the sale of the cotton and seed, and naturally make a point of obtaining the best possible price. For these services we charge a small commission, which provides a substantial sum towards the payment of our standing expenses. We also supply machinery, plant, baling material, seed, etc., on easy terms of repayment. The value of these services can hardly be over-estimated. One great difficulty which every tropical planter has to face is how to obtain a fair price for his produce, but everyone who grows cotton in co-operation with the Association has at least the satisfaction of knowing that there is an "honest broker" at home who will look after his interests like a brother.

In addition to this "commercial" work the Association is also in constant communication with the agricultural departments and other officials in the colonies, and a large amount of time and correspondence is devoted to discussing the many problems which are connected with the development of cotton-growing throughout the Empire. I should like to take this opportunity of expressing our thanks to the numerous officials who have so often given up some of their well-earned leave to come to Manchester to discuss these problems with us. There is no doubt that even half an hour's conversation is worth yards of letter-writing.

The Association owe an immense debt of gratitude to the Duke of Marlborough for inaugurating the conferences at the Colonial Office. At these meetings representatives of the Association hold friendly discussions with the officials, and so easily and expeditiously dispose of problems which might otherwise be insoluble. Notwithstanding these meetings, we have to carry on a voluminous correspondence with the Colonial Office, and the letters which have passed between us during the last nine years fill sixteen good-sized books.

My object in giving this somewhat lengthy description of the work of the Association is to enable you to understand the enormous task we have undertaken, and the almost overwhelming nature of our work, and so to appreciate the additional difficulties we have had to face in consequence of this terrible war.

Fall in Price of Cotton.

The most serious problem which the Council had to consider when war was declared was the big fall in the value of cotton. All systems of credit and of international exchanges, which had taken almost centuries to build up, practically disappeared in one day, and no one could say what would be the effect on the price, not only of cotton, but also of every article of produce and of every security, whether it were land or buildings, or stocks or shares.

During the first half of 1914 the price of American cotton had averaged about 7*d.* per lb. Notwithstanding the fact that the Liverpool and New York markets were closed, by the end of October the price had fallen to 5*d.* per lb., and in the middle of December Middling American was almost unsaleable at 4¼*d.* per lb.

This meant a big reduction in the buying price to the planter, and serious as the effect might be

in countries like the United States, India and Egypt, where cotton-growing had been established for half a century or more, much more anxiety was felt as to the results it might have in those countries where cotton-growing was of recent introduction. In cases where the industry depended on European planters the situation was not quite so serious, for they would, at any rate, appreciate the difficulties of the market. Where, however, as was the case generally, cotton-growing depended solely on the natives, the fear was that if the buying prices were very much reduced they might be seriously discouraged, and that they would reduce their planting of cotton, and might even abandon the industry altogether. As can be imagined, the Council passed through a most harassing and anxious time. However much they might desire to save this industry, which had taken so much trouble and expense to build up, the capital at their disposal was only limited. They, however, decided that this was a time for bold and generous action, and even if the Association were to suffer serious losses in maintaining the industry the money would be well spent from an Imperial point of view.

Policy of the Association.

The policy the Council laid down was that this was not a time to be thinking of making money, and therefore that it was essential that the native producer should receive a generous price for his cotton. It was also the paramount duty of the Association to ensure, as far as possible, that every single native farmer should be able to dispose of his cotton even if it were at a low price. In those districts where the Association had the buying in their own hands they must pay the highest possible price the market would allow. In other colonies, where the buying was done through other channels, if the buyers were not prepared to help by working for a time with a small margin of profit, or if they were inclined to leave cotton-buying alone as not sufficiently profitable, it might be necessary for the Association to step in and take their place.

It will be agreed that the Association adopted a bold and statesmanlike policy, and that the Council deserve the highest commendation for risking, as they did, the whole of the liquid capital of the Association. It remains to be seen what the financial result will be, but if it means that half the capital of the Association has been lost, it will have been in a good cause.

The adoption of a policy, however good it might be, was not sufficient in dealing with difficulties of this sort, and the Council immediately set to work to devise practical measures to meet the circumstances of each particular case. I propose to give you, as shortly as possible, an account of the actual measures taken by the Association to try to save the industry, but I should mention that we have received no financial help whatever from the Government, although we were voluntarily taking on our shoulders a task which should more properly have been performed by the Government. What, however, did more than anything else to save the situation was the fact that, after touching a minimum price of $4\frac{1}{4}d.$ in December, 1914, the price of cotton began to rise as soon as the Liverpool market was reopened. In January, 1915, the price again reached $5d.$, and afterwards remained slightly above this level, with fluctuations between $5d.$ and $5\frac{1}{2}d.$, until the end of August. Afterwards there have been very big fluctuations in the price, which is to-day about $8d.$ per lb., but this last rise came too late to help us in our work.

Finance.

One of the most serious difficulties the Council had to face was that of finance. Cotton is essentially a cash crop, and this involves the provision of a large amount of silver coin for purchasing the cotton, which again means the arrangement of the necessary bank credits. No one could foretell how the banks were going to be affected by the war, and I think it is very much to the credit of our banking friends that they boldly faced the situation and provided us with credits amounting to over £500,000 to enable us to finance the various crops. This also reflects the greatest credit on the reputation of the Association. Had it not been for the high character we have acquired for careful and honest business methods I do not suppose we could have obtained these credits. What helped us most was the recognition by the banks of the fact that we were working for no selfish motives, but for the good of the Empire, and consequently we were able to obtain financial assistance which would not have been granted to ordinary commercial firms. Perhaps some day the Association may be compelled to work on strict business lines, but I am convinced that in the interests of the Empire it is essential that the philanthropic character of the Association should be maintained for many years to come. Perhaps the best solution of the difficulty would be the establishment of the Association as a permanent "Trust."

Nigeria.

In Nigeria, although cotton was bought mainly by the merchants, as our agents, the price was fixed by the Association. Prior to the war the buying price was $1\frac{1}{8}d.$ per lb. of seed-cotton. As it takes about $3\frac{3}{4}$ lb. of seed-cotton to give 1 lb. of lint, this means a first cost of about $4\frac{1}{4}d.$ per lb., which, after allowing for cost of ginning and baling, freight, and other expenses, was equal to about $6\frac{5}{8}d.$ per lb. in Liverpool.

As I mentioned before, the Liverpool price had dropped to $4\frac{1}{4}d.$ per lb., and even if we reduced the buying price by 50 per cent., or to $\frac{9}{16}d.$ a lb., we should have no margin left to cover working expenses. The merchants most generously agreed to sacrifice $\frac{1}{16}d.$ per lb., or half their commission; Messrs Elder, Dempster & Co. arranged to allow a rebate of 25 per cent. off the ocean freight; and the Nigerian Government also agreed to a rebate of 25 per cent. on the railway freight. These concessions together amounted to slightly over $\frac{1}{8}d.$ per lb., and the Council decided to fix the buying price at $\frac{3}{4}d.$ per lb., which would involve a loss of $\frac{1}{16}d.$ per lb. in addition to the working expenses. The buying price was subsequently increased to $\frac{7}{8}d.$ per lb., when the Liverpool price rose to $5d.$, and it was afterwards raised to $1d.$, or only $\frac{1}{8}d.$ below the original price. I think it will be conceded that the Council undertook more than could have been reasonably asked of them, and especially so as the arrangement will probably result in a loss to the Association of over £10,000.

Nyasaland.

In Nyasaland the buying was partly in the hands of the Association, and was partly carried out by local firms. When the Liverpool price fell the latter withdrew from the market, and the Association were left to bear the burden single-handed. The Council boldly faced the situation, arranged the necessary finances, and purchased practically the whole of the native-grown crop at prices which were considerably above the market value. This must involve some loss, especially as they have had to pay, not only here, but from other parts of the Empire, enormously increased rates for freight and insurance. Let us hope that the Government will tax heavily all those who have utilised the opportunity afforded to them by the war to make extra profits out of the misfortunes of their fellow-countrymen. In any case it is no benefit to the industry to have to pay increased rates, even if the Government were to take the whole of such extra profits.

Uganda.

The situation in Uganda was the most difficult of all. Cotton was the main export industry of the country, and unless means could be provided for marketing the crop it would be a most serious disaster for the colony. The natives would suffer most severely, and the Government would have to face a serious financial deficit. There was also grave danger that the natives might be so discouraged that they would abandon the industry altogether, and if this were to happen it might be impossible to revive it. This would have been a serious disaster for the colony, and the Government revenue would have fallen off so seriously that a grant-in-aid from the Home Government would be required to meet the deficiency. In consultation with the Colonial Office and two of the principal buying companies the Association drew up a very comprehensive scheme, involving a credit of £600,000, which would provide all the buying and ginning firms with funds to deal with the whole of the native-grown crop. The Treasury also agreed to help in case of need. The Association were also prepared to consider any modification of the scheme which would enable the buyers to pay a fair price to the natives, and which would at the same time give the former a fair margin towards working expenses.

I regret to say that the principal local buying and ginning companies took a very narrow-minded view of the situation, and were not prepared to accept the policy put forward by the Association, that this was not the time to be thinking of making money, and that every effort should be made to encourage the natives to continue the industry by paying them the highest possible price for their cotton. They strongly opposed the scheme, which had therefore to be abandoned and other steps devised to meet the difficulties of the situation.

Unfortunately during these negotiations valuable time had been lost and the crop was beginning to come forward. The following quotations from the annual report of the Director of Agriculture will, perhaps, best illustrate the difficulties of the situation:—

"For over six months of the year cotton was practically unsaleable, and the growers were left for months with the crop on their hands and wholly unable to provide adequate storage accommodation. Large areas were neglected and uprooted, and in some cases the cotton was burnt and otherwise destroyed, as the producers gave up all hope of being able to sell their crop."

"The position was aggravated owing to the fact that some firms, usually large buyers of

cotton, were out of the market. Even under ordinary circumstances it is with the greatest difficulty that the crop is moved."

The Council therefore had to make hurried arrangements for direct operations. Luckily one of their West African managers, Mr. Worsley, was already on his way to Uganda, where he had been sent to inquire and report on the industry generally. A credit of £150,000 was arranged, and two of the smaller companies voluntarily placed their staff and their ginning factories at our disposal, and the Government arranged to lease to the Association a third factory belonging to a German firm which had been closed down owing to the war. The buying price was first fixed at 5 cents of a rupee, and was subsequently raised to 5½ cents, which is equal to about 5½*d.* per lb. of Middling American in Liverpool. I am glad to say that, notwithstanding the hurried and rather inadequate arrangements, the Association were able to deal with no less than 9,000 bales, or fully one-third of the whole crop. Prior to the intervention of the Association the other firms were paying very low prices for the cotton, but afterwards they had to raise their prices or stop buying. It was a misfortune that the Association were limited in the quantity they could buy owing to the small capacity of the ginning factories at their disposal, otherwise they might have bought a very much larger proportion of the crop. It is no exaggeration to say that the bold and prompt action taken by the Council has saved Uganda from a certain disaster, and even if it does, as is probable, involve the Association in considerable losses, the Council will consider the money well spent.

One could not have a better example of the immense value to the Government of a philanthropic body like the Association, and of the danger of leaving the natives at the mercy of ordinary commercial firms. The Council have since been informed that some of the other firms consider it most unfair that the Association should have intervened as they did. These gentlemen have, however, no one but themselves to blame, for if they had been willing to help, even in the slightest degree, the Association would never have intervened and would further have given them all possible help.

The Government fully appreciate the action taken by the Association, and in February, 1915, a letter was received from the Colonial Office, stating that :—

"Mr. Harcourt desires to take this opportunity of expressing his warm appreciation of the public spirit which the Association have shown in their desire to take all possible steps to safeguard the industry."

Anglo-Egyptian Sudan.

In the Anglo-Egyptian Sudan the situation was also one of considerable difficulty. The industry is one of the most important in the country, and, owing to the war, all ordinary channels of credit were closed, and the usual buyers were not in a position to operate. Cotton-growing in this country is almost entirely a native industry, and there was a fear lest the natives might not be able to dispose of their crops except at ruinous prices. The Association were approached by the Government through the Sudan Plantations Syndicate, and the council were able to arrange for a credit of over £200,000, and consequently the whole of the Sudan crop was marketed at not unsatisfactory prices.

The following extracts from letters from Sir Reginald Wingate will show that the assistance rendered by the Association has been much appreciated :—

"Khartoum, January 29th, 1915.

"In this country it is not only a question of securing for the cultivators a fair price for their 1915 crop, but of preventing, if possible, their faith in cotton as a source of profit being shaken."

"Khartoum, March 8th, 1915.

"I should like to take the opportunity of saying how much I appreciate your cordial help in a difficult question, which now offers every prospect of a satisfactory solution, and I am grateful for your kind offer of future assistance. It will be a great benefit to the future of cotton-growing at Tokar that, in a year like the present, the cultivator has been provided with an opportunity of selling his cotton on the spot for cash."

West Indies.

In the West Indies, where the bulk of the cotton crop is grown by white planters employing native labour, the outlook was most serious. The crop consists almost entirely of the best quality of Sea Island cotton, which is used for spinning the very finest yarns, the principal demand for which is for lace-making. Owing to the war there was an absolute cessation in the demand for luxuries, and West Indian cotton was utterly unsaleable even at ruinous prices. There was therefore the gravest danger of the planters abandoning the cultivation of cotton, and more especially so as sugar was fetching high prices. The Council approached the Fine Cotton Spinners' and Doublers' Association, who are the largest users of Sea Island cotton, and I am glad to say that

this company took a wise view of the situation and offered to guarantee a minimum price for the 1915 crop, and the price offered was very much above the value then ruling in the market. Since then there has been a considerable rise in the value of Sea Island cotton, and it is therefore to be hoped that the industry will continue as before.

Results Obtained.

The Council are not given to blowing their own trumpet, and therefore I think it is only right that the public should be informed of the action they took to meet a most difficult and serious situation. I think it will be generally admitted that they adopted a broad and statesmanlike view of their duties. I do not pretend that better measures might not have been devised to overcome the many difficulties with which they were faced; but it must not be forgotten that business and finance were in a state of chaos, and that there was little time to be lost, and consequently everything had to be done in a hurry. Nor should it be forgotten that the liquid capital of the Association was little over £100,000, and this would not go very far in financing a crop worth over £1,000,000. I should also mention that although the Treasury had promised to find a considerable sum of money to save the Uganda crop in consequence of the Association's scheme having to be withdrawn, the Government were not asked to find one single penny either in Uganda or elsewhere, and the Association have had to bear the burden alone.

The question naturally arises as to the results of the Association's action and whether the industry will continue to progress in the future as it has done in the past, or whether it has received a set-back from which it will take a long time to recover. It is a little difficult to give a definite opinion on this point at the present moment, but it is of no use pretending that the situation is any better than it really is. The view taken by the Council is that, as far as can be judged at present, the industry has received a set-back, and that it will require careful nursing to set it again on its progressive march. In order to enable you to appreciate the position as it now stands, I propose to give you a short *résumé* of the reports we have received from the various centres in which we have been operating.

Lagos.

In Nigeria we have two main districts, along the Lagos railway between Lagos and Jebba on the River Niger, and in the Northern Provinces along the railway between Jebba and Kano. Our reports from Lagos show that a smaller quantity of seed was distributed in 1915 than in 1914. Luckily the climatic conditions have been favourable, and as it may be possible to raise the buying price to the old standard of $1\frac{1}{8}$*d.* per lb., it is probable that this year we shall see as large an area planted as before. Steps are being taken to introduce an improved variety of cotton, and the Association have guaranteed an extra bonus for all cotton grown from Government seed. If these efforts are successful we may see cotton-growing extend rapidly in this district.

It is rather difficult to know how much cotton has been planted in Northern Nigeria, but I am glad to say that our latest reports state that so far the Association have purchased a much larger quantity of cotton than in 1915. Here also efforts are being made to establish a better quality of cotton.

Although the Association may be compelled, for financial reasons, to close down outlying stations and to restrict their operations to the railway, I think the prospects are distinctly promising, and that the set-back in Nigeria will be only of a temporary nature.

Nyasaland.

There is no doubt that in Nyasaland both the planters and the natives have suffered considerable losses owing to the fall in prices, which have been added to by the largely increased rates of freight demanded by the steamship companies. As I stated previously, the Association did all they could to alleviate these losses by paying the highest possible price for the cotton. The officials also did their best to explain to the natives that the low prices were due solely to the war, and were therefore temporary, and it is satisfactory to know that there is likely to be a considerable increase in the planting of cotton in 1916.

Uganda.

In Uganda I am afraid that we are going to have a serious set-back, and it is impossible to say at present when the industry will recover from it. It may take several years before cotton is planted even as largely as in previous years, and I am afraid one must not look for any large increase in the immediate future. As was stated in the report of the Director of Agriculture, the natives, being unable to find a market for their produce, uprooted the plants and burnt and destroyed

the cotton which had been picked. It is more than a misfortune that the Association were not previously established in this colony, and that they were only able to commence operations when the season was well advanced. Had it not been for their intervention—late as it was—it is more than probable that cotton-growing would have disappeared entirely and finally in many districts in Uganda.

In view of the seriousness of the situation the Council have decided to continue their operations for at least another season, and it is more than probable that the Association will have to go on working in Uganda for several years to come. This, however, must depend on our financial position. Our subscribed capital is about £480,000, of which £178,000 had been spent on experimental work up to December 31st, 1914. This amount will probably be increased to £200,000, when we allow for the losses incurred in 1915 in our efforts to save the industry. It therefore stands to reason that we cannot afford to devote much more money to philanthropic or unremunerative work.

Anglo-Egyptian Sudan.

In the Sudan I think we can look confidently to the prospects for the future. Owing to the help rendered by the Government in co-operation with the Association, the natives received quite a fair price for their cotton. It is, therefore, expected that cotton will be planted as largely as before, and that its cultivation will continue to increase.

There can, however, be no large increase unless the money is found for the construction of the necessary works for the irrigation of the Gezira plain. No doubt after this war is over the financial position will be one of the gravest difficulty; but however much the Government may be compelled to cut down expenditure, I should consider it an economic blunder, and almost a breach of faith, if they were to go back on their promise to guarantee the interest on the loan of £3,000,000 to the Sudan Government. It should not be forgotten that this is not a mere paper scheme. It has already been proved. We have at the present time two large experimental areas in full working order, one of which has been under cultivation for nearly five years. "Experimental" is really the wrong word to use, for these plantations are respectively about 1,500 and 2,500 acres in extent, and are therefore business propositions. I am not at liberty to give you the figures, but I can assure you that these two propositions are successful already, even from a purely commercial point of view. The full scheme, therefore, cannot fail to be a success, and it would be an obviously mistaken policy to delay the issuing of the capital through any mistaken idea of economy, for I am convinced that the British Government will never be asked to find a single penny through failure of the Sudan Government to provide the interest on the loan.

Beneficial Results of Cotton-Growing.

While on this point, I should like to draw your attention to the beneficial results which have accrued to the Empire in consequence of the work of the Association in extending the cultivation of cotton. An estimate was recently submitted to the Government, showing that the Colonial revenues were benefiting to the extent of no less than £130,000 per annum in direct consequence of the cultivation of cotton. This figure could easily have been increased to £150,000 without overstating the case. It was also shown that the revenues of the steamship companies derived from cotton was over £100,000 a year. Insurance companies, bankers and others have also derived large additional revenue in consequence of our work. Nor are the benefits confined to the above-mentioned interests. It must not be forgotten that every pound's-worth of cotton which is produced for export, and which does not replace some other product, means a corresponding importation of manufactured articles or other goods. The cotton and seed produced under our auspices now amount in value to over £1,000,000 per annum, and it is no exaggeration to state that we have increased the demand for British manufactures to the extent of at least £500,000 a year.

This fact is one of profound importance when we come to consider the growing necessity for new markets for our manufactures, a necessity which will probably be much more pressing after the end of the war. It must not be forgotten that, generally speaking, we are creating an absolutely new trade, and enabling the natives to produce an article for export in those districts where an export trade was previously impossible. Cotton is an article of high value, and can therefore stand considerable expense for freight. It would be folly to attempt to grow maize or other products of low value in the heart of Africa, as the cost of freight and charges would be almost as much as the total value of the article. Cotton, however, can be, and is at the present moment being, produced in the centre of Africa on an economic basis.

The Future.

Before I conclude I must say a few words about the future. About the necessity for our work there can be no doubt. In the five years ending in 1895, the United States used 31 per cent. of their crop. In the last five years their requirements have risen to 37 per cent., and in 1915 they used over 6,000,000 bales. The crop now being marketed is probably not more than 11,500,000 bales, and it is expected that this year their consumption will be at least 6,500,000 bales, or over 56 per cent. of the total crop. We must face the fact that, sooner or later, America will need almost the whole of her crop for her own requirements, and therefore, unless new cotton-fields are rapidly developed, most of our cotton-mills will have to stop, and a large proportion of the population will be compelled to emigrate in order to find employment.

Anyone who is interested in the question ought to read a book recently published by Mr. John A. Todd, Professor of Economics at the University College of Nottingham, entitled "The World's Cotton Crops." It is the best, and I might say the only, book giving an account of cotton-growing throughout the whole world. The last chapter deals with the effects of the war, and the concluding passage is well worth quoting:—

> "But one thing is certain: when the war is over we shall require an increased supply, especially of fine cotton, and we must look for it mainly to our own Empire, especially in India and Africa. We shall then want, not merely a British Cotton-Growing Association, with a capital of a paltry half-million, but an organisation of the size of a State Department, with all the Governments of the British Empire behind it, and a capital of about as much as is spent on this war in a day, say, £10,000,000."

Our work so far has been mainly experimental. We have been examining, inquiring, and experimenting in order to ascertain which colonies offered the best prospects of success. What we have to do now is to extend and develop these various ventures on a very much larger basis. So far from having come to an end of our work, we are really only just commencing it. An annual production of 100,000 bales, though worth over £1,000,000, is infinitesimal when one remembers that Lancashire uses over 4,000,000 bales of cotton every year. Further, there are plenty of experiments yet to be carried out, and there are large districts as yet untouched. Our work in Northern Nigeria is only just beginning, and it is more than probable that the new railway from Port Harcourt to the Benue River will open up large cotton areas. There is a large extent of country in Nyasaland and North-Eastern Rhodesia absolutely undeveloped, and we have only just begun to realise the large possibilities in Uganda. In the Sudan, as I mentioned before, there is an immense amount of work to be carried out in the immediate future, and there are large districts in the south with enormous possibilities for later development. No one can say what may be the result of the war and whether additional territories may be added to the British Empire. I may, however, mention that German East Africa is a country where a fair amount of cotton is already grown, and that in Mesopotamia there are possibilities of growing sufficient cotton to keep half the spindles of the world fully employed.

You will, therefore, realise that we have an immense amount of work before us, if we are able to undertake it. There are, however, two essentials—ample means, which we certainly do not possess at present, and unfailing and enthusiastic assistance from the Government. I do not mean financial assistance but hearty co-operation in our work, and such help as can be given by the construction of railways, roads, and other facilities which benefit all trades alike. This assistance we have received in the past, and the Council confidently expect that we shall continue to receive it in the future, for without it it would be useless attempting to continue our work.

It has been suggested that the time has come for the Association to work on purely commercial lines. In the opinion of the Council this is a mistaken idea. There are still many experiments to be carried out and a great deal of pioneering work to be done. As I explained before, this work is unremunerative, and it is not to be expected that ordinary commercial firms would face the losses which are unavoidable. Further, in consequence of the war still greater efforts of a philanthropic nature will be required to maintain the industry even at its former level, and much more will have to be done if any extension is to take place. The Council are convinced that if the Association are compelled to work on purely commercial lines, and if they have to make the extension of cotton-growing subservient to the earning of profits, it will be nothing less than a calamity for the Empire.

Amongst the lessons which I hope this terrible war should teach us, there is one which I trust we shall not fail to learn and to apply in a practical manner—that we should grow, as we

can do, within the British Empire, all the cotton required by our mills, and so make them perfectly independent of all foreign countries. The war has undoubtedly given the cause of cotton-growing a set-back, but I am glad to say that the Council are in no way disheartened or dismayed. If we can obtain the whole-hearted support of the Government we have every intention of continuing to develop to the best of our ability what has been aptly described as "The greatest Imperialistic movement of modern times."

DISCUSSION.

The Chairman (Sir Daniel Morris, K.C.M.G., D.C.L., D.Sc.), in opening the discussion, said the author had given an admirable account of the work of the British Cotton-Growing Association, and he was sure everyone present must be impressed by the magnificent work the Association had been carrying on, for the last twelve or thirteen years, in all parts of the world. He did not think that work was as well known as it ought to be, but people in Lancashire and in the various colonies where cotton was grown all felt the very greatest gratitude to the Association for the way it had helped them through bad times and enabled them to continue their work. As regards the various grades of cotton, the highest class was that known as Sea Island cotton, which was exceedingly strong. It had hitherto been grown in the Southern States of America, especially in South Carolina and the Sea Islands, and was originally obtained from Barbados. When the attempt was first made to introduce cotton-growing into the West Indies, he went to the United States to make inquiries as to the possibility of growing the ordinary American cotton; but there were many difficulties in the way of doing so, one being that the price was too small for the intensive cultivation that was carried on in the West Indies. In the following year he went to the United States again to study the Sea Island cotton, and he finally decided to purchase a large quantity of the seed to take to the West Indies. That seed was distributed to the planters there, and in the first year they planted about 5,000 acres with it. The cotton was shipped to Liverpool and was bought by the fine spinners to make yarn for such articles as lace, chiffon, and other materials of that kind. Brussels lace was also made from Sea Island cotton, which was really the finest in the world. When the industry was first started in the West Indies, people in the Southern States of America felt quite sure they could hold their own, and they were very surprised when, in the first year that cotton was grown in the West Indies, it obtained 2*d.* a lb. more than that which was grown in the Southern States. They were also surprised at the large quantities of cotton that the West Indies produced. He believed the Fine Spinners' Association in Lancashire largely depended upon the supplies from the islands. The very best Sea Island cotton exported from the West Indies had obtained a price of 4*s.* per lb., although that of course was in very small quantities and under exceptional circumstances. That cotton was grown in an island that was visited by a terrible eruption in 1902, and at one time it was thought the island would have to be abandoned altogether as being too dangerous, but that little island was now coming to the front as producing the finest cotton in the world. The cotton could be grown as an intermediate crop with the sugar-cane, so that it did not interfere with the cultivation of sugar. With regard to the work of the agricultural departments, to which the author had referred, the Imperial Department of Agriculture in the West Indies was started by the Home Government as an experiment, on the recommendation of a Royal Commission, to see whether some kind of scientific agriculture could not be established in certain parts of the British colonies. The Department had proved a great success, and at a dinner given at the West Indian Club recently Mr. Asquith said the experiment was one of the most gratifying undertaken by any Government, because the results were so very striking and were brought about in so short a time. Similar agricultural departments had now been established in practically all parts of the tropics—in India, Ceylon, the Malay States, Mauritius, the Gold Coast, Sierra Leone, Upper and Lower Nigeria, and Fiji. Of the men that were trained in the Department of Agriculture in the West Indies, one was at the present time Director of Agriculture in Mauritius, another held the same post in the Malay States, and a third in Fiji. He thought the author was rather too pessimistic about the present position of scientific agriculture in the tropics. In the last few years there had been a considerable improvement in that direction, and planters in the tropics were now convinced that science could help them a great deal. As a proof of the value of science in assisting the practical planter, he might mention that there was a certain disease prevalent at one time amongst sugar-canes, caused by the sugar-cane moth, which resulted in a loss of several thousand pounds a year. A young man from Cambridge, who had never seen a sugar-cane before in his life, was sent out as Official Entomologist to the Department, to trace out the life history of the moth and see whether the disease could not be stamped out. The planters did not believe he could do it, but in twelve months he was successful, and that helped to convince them of the benefits of science as applied to agriculture. That confidence was now extending to different parts of the Empire, and he did not think the British Cotton-Growing Association would have the same difficulties to contend with in the future as they had had in the past.

Mr. Theodore Walker asked what country was the natural habitat of cotton, and also wished

to know whether the cotton plant was an annual or a perennial. He noticed that the author did not refer to the carriage of cotton, which was a very important matter. In the West Indies it was quite a simple business to export cotton, as the islands were small, and therefore no part of them was very far from the coast; but in Uganda, for instance, it was a very different matter, as it had to be brought to the Uganda railway, and then carried a long way by rail. He also thought that difficulty was experienced in obtaining fuel for the ginning engines. He believed cotton could not be grown with advantage more than fifty or sixty miles from a good road or railway, as it was very heavy for men to carry. He would also like to know whether cotton was injured by too much or too little rain.

Sir Frederic M. Hodgson, K.C.M.G., said he was Governor of Barbados at the time when the British Cotton-Growing Association began its work there, and when Sir Daniel Morris was in charge of the Agricultural Department of the West Indies. The cultivation of cotton was carried on in Barbados at the time of the cotton famine in Lancashire, and the Association, with the valuable assistance of Sir Daniel Morris, did a great deal to re-establish the industry, which was now in as flourishing a condition as was possible considering the short time that had elapsed since its re-establishment. No doubt the planters there would find it to their advantage to carry on other industries as well, as was the case in Barbados and in British Guiana. In the latter country, of which he was Governor for seven years, the people found it more advantageous to cultivate rice, and the cotton industry was not so successful, although whilst he was there the Department of Agriculture established experimental stations and tried to turn the attention of planters to cotton-growing. He agreed with the author that it was a black man's industry and should be left to black men as much as possible. In the same way the cocoa industry in the Gold Coast had been left in their hands, and had made extraordinary progress, largely on that account. With regard to the credit required in the cultivation of cotton, more especially in West Africa, he hoped it would be possible to establish in that country, and in all tropical countries where black men were to be found, what were known in this country as Co-operative Credit Banks. He tried very hard to form such banks in British Guiana, and believed they had been established since he had left the country. They had, of course, to be under the direct supervision of the Government. When he was in British Guiana the following plan was adopted for enabling the natives to improve the cotton they were growing. Cotton-seed of a good quality was sown along the sides of the roads, and when it grew up the natives, as was anticipated, stole it, and took away the seeds to plant for themselves. In one of the prisons a native prisoner was supplied with a loom to weave cotton cloths, a specimen of which was in his (the speaker's) possession.

Mr. John H. Harris thought something might be done to educate the native producers in the advantages of cotton-growing. He had discussed the question with many natives in West Africa and South Africa, and found they had very little knowledge of the work of the British Cotton-Growing Association. A few months ago he met a white man in the Orange Free State who said he wished to grow cotton, but did not know where he could obtain the seed. Fortunately he (the speaker) was able to give him the address of the Association. He would like to ask the author whether the Association could not use the educational organisations in the African colonies, in order to spread a knowledge of its work and of the great advantages the African producer might obtain from the cultivation of cotton. If the missionary societies and Government schools would occasionally offer a prize for a paper on cotton-growing, that might materially assist in the spread of knowledge concerning that industry, and possibly lead young men later on to devote themselves to scientific study of the subject.

Mr. Alfred Machen referred to the wonderful results which had been achieved in cotton-growing at Kew Gardens with the aid of Professor Bottomley's Humogen, or bacterialised peat, and was sure the British Cotton-Growing Association would be supplied with some of that material for testing purposes if they cared to apply for it.

The Chairman, replying to some of the questions that had been asked in the course of the discussion, said that with regard to the origin of cotton there were many different varieties found in various parts of the world in a wild state. Sea Island cotton was no doubt once a wild plant found in the Barbados. In reply to the question as to whether cotton was an annual or a perennial, it was really a perennial; but the best kinds, such as Sea Island cotton, Egyptian cotton, and the long-staple cotton in the United States, were cultivated as annuals. In some parts of the world, when the crop had been taken off, the heads of the plants were cut off, the stumps being left in the ground. When the rains came again in the following year shoots grew up from the stumps, and in that way a crop could be obtained and the process could be adopted for two or three years.

Mr. J. Arthur Hutton, in replying to the discussion, said that cotton was an article of high value, and could therefore stand a considerable amount of money being spent on its carriage. A gas-engine for ginning had been invented and brought to a state of perfection, the fuel for which was produced entirely from the cotton-seed itself.

Cotton had been grown in West Africa for over a century, and in Northern Nigeria there was a big cotton industry being carried on at the present time. England used to obtain cotton from the West Indies about a hundred years ago, so it seemed rather an irony of fate that English people should now have to go and re-establish the industry there. The Council of the British Cotton-Growing Association had been very much impressed by the idea that the cultivation of cotton was a black man's industry, and there was only one way to induce him to carry on that industry—*i.e.*, to make it profitable for him to do so. With regard to Professor Bottomley's work, the Association was most grateful for the offer that had been made and would be very glad to consider the matter.

On the proposition of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Hutton for his interesting paper, and the meeting terminated.

"ENGLISH AND GERMAN METHODS CONTRASTED."*

By SIR ROBERT A. HADFIELD, D.Sc., F.R.S.

I should like to bear testimony to the very valuable nature of Dr. Dugald Clerk's recent and most interesting address, and as you are good enough to invite me to add a few comments I have much pleasure in doing so.

In January last (1915) Sir Philip Magnus contributed a letter to the *Morning Post* in reference to certain Jeremiads which had appeared with regard to the uncalled-for remarks by one of our public men who surely should have known better. Lord Haldane made the remark that we in this country "have been behindhand in the application of science to industry, and that we should be better off to-day if we had put anything like that devotion to the task of applying science to industry which has been notable on the Continent."

As Sir Philip Magnus pointed out in his reference to Lord Haldane's remarks, the fact that England was not so well off when the war broke out, or for some time afterwards, was not due to any absence of seriousness on our part "in regard to education," but to other causes. He also said: "Lord Haldane never loses an opportunity of contrasting unfavourably our scientific education with that of other countries, particularly of Germany. There is no lack of men in this country, trained at our universities and technical schools, who are capable of applying the most recent results of scientific research to industrial problems, including the manufacture of implements of war and artificial dye-stuffs. For the economic success of their efforts the encouragement of the State was alone needed." With these remarks of Sir Philip I most heartily agree, and the statements in Dr. Clerk's excellent address bear out this conclusion.

In correspondence between Sir Philip Magnus and myself he was good enough to say that certain testimony I sent him, such as that to which I now refer, should go a long way to shatter the German idol of scientific superiority so long worshipped in this country. He added that he had done his best, both in the House of Commons and on many platforms, to show that German education, reviewed as a whole, and tested by its capacity of turning out men of general intelligence and high moral character, is decidedly inferior to our own, which testimony is referred to in the next paragraphs.

On this question possibly a few words of personal experience are more valuable than theoretical considerations. In my own line of research work, the science of metallurgy, I can, after long experience, truthfully say that to the best of my knowledge we have never been indebted to Germany for a single basic principle. At my company's works in Sheffield, with some twelve thousand men at work, and where most of my research work, extending over thirty years, has been carried out, I am not aware that we have any German process or apparatus in use. I believe that we have still some German beakers in our laboratory, but I am glad to think that they are now being replaced by English-made glassware.

The results of these researches have been embodied in some sixty or more papers and contributions to the Royal Society, Iron and Steel Institute, the Civil, Mechanical, and Electrical Engineers, and many other scientific and technical bodies. The research work done has thus not been selfishly kept in our own laboratories, but the knowledge obtained has been in due time made generally available.

As regards the discoveries and inventions effected and there described, manganese steel, low hysteresis steel, also many other special alloy steels, have now been adopted throughout the world since my first iron-manganese alloy paper was presented in 1888, which was practically the beginning and origination of this particular branch of investigation; in fact, many of these inventions have been adopted by Germany herself. I cannot recollect a single instance in which I have been indebted for basic principles to Germany—not, of course, that I have not appreciated their energy, perseverance, and devotion to science; but this can also be said of other nations, including our own.

American and Continental writers have been good enough to say that my first research in manganese steel was not only important, but was, to use the words of Osmond, the leading French metallurgist, "a discovery which ranked equally in importance to that of the effect of quenching carbon steel, and was the only one of the same order which it had been reserved for our age to make."

* This communication, which was despatched on December 11th, 1915, was delayed in transmission, and has only just been received.—ED.

In respect to scientific progress in metallurgy, we in this country admit that we are much indebted to France, but not to Germany. I would refer to one instance specially, namely, the wonderful and painstaking work of Professor Henri Le Chatelier, who, by his researches, has enabled us to carry out wonderfully accurate measurement of high temperatures. It may, too, be added, and must not be forgotten, that Wedgwood, an Englishman, was several generations ago one of the leaders of research in this direction. Later, Professor Callendar has added greatly to our knowledge; also Dr. Whipple, of Cambridge—all of them obviously not Germans.

As the readers of our *Journal* know, an excellent paper on this subject was contributed to our Society a few months ago by Mr. Chas. R. Darling, entitled "Recent Progress in Pyrometry," from which it would be seen that little, if any, credit on this matter could be claimed by Germany. In other words, they have rather utilised British, French, and American investigations.

I would here like to refer to a very excellent pamphlet, entitled "La Science de Civilisés et la Science Allemand," recently published by Monsieur P. Achalme. It deserves to be read by every scientific man, and I hope some translation will make its excellent conclusions more widely known in this country, showing, as the pamphlet does, that Germany has been very much overrated in the world of science. The Hun has applied and copied from others, but not originated.

The Bessemer process, from which Germany has derived so much benefit, was certainly not invented there. The discovery of the basic steel process, as is well known, was also due to our chemists, Thomas, Gilchrist, and Snelus, and to M. Pierre Martin, in France. It is to this process that Germany is largely—in fact, chiefly—indebted for its developments in the production of cheap steel. Moreover, Germany obtained most of her ideas about metallurgical plants from the streams of Germans who visited our cousins over the water to pick up, and not improperly so, all the information they could whilst America was developing her steel industry. Still that was not origination; it was copying.

As an engineering point it may be interesting to note that a great deal of the German export business has been developed by bounties, for example, amounting to as much as 30*s.* per ton of steel rails. Imagine what it would have been if the metallurgical industry of this country had been supported by such enormous bounties. I am not speaking of the rights and wrongs of such a policy of bounty, but it is unfair conditions of this kind which have largely enabled Germany to fight us, including, for example, the misuse by Germans of patents in Great Britain.

A very shrewd and naturalised German in this country told me long before the war that until we made up our minds to stop this unfair competition our iron and steel industries were bound to suffer, and could not make progress in the direction of much larger production.

Personally, I may say that Krupp has worked a number of my own patents; so evidently he did not consider that he possessed all the metallurgical wisdom in the world.

The late Dr. Geheimrath Wedding, of Berlin, was good enough to say, when he visited my company's laboratories at our works in Sheffield in 1905, during the Iron and Steel Institute meeting there, that "the research laboratory of the Hadfield works is of a completeness which would serve as an example to every academy in Germany."

I believe, therefore, that I shall have every Englishman with me when I say that the Jeremiads of Lord Haldane and others are thus not only foolish and incorrect, but are most unpatriotic. It has been, therefore, with unusual pleasure that I have read the courageous and perfectly accurate address by Dr. Clerk on November 17th.

In saying this I see no reason not to add that, like many Englishmen, I have received the utmost kindness and courtesy during my trips to Germany. Whilst fully recognising the hard work and perseverance of the Teuton, nevertheless I have never met in this nationality anything which seemed to show the superiority about which some of those in our country seem to have had a mania for continually expressing their admiration, with its consequent great harm.

I have not the slightest wish in making this remark to depreciate the excellent work of German scientists. It has been a sad sight to see so many friends in the world of science in that country uttering sentiments that, but a few years ago, they themselves would have been astounded to imagine they could ever utter; and to read, as our then head of the Royal Society, Sir William Crookes, of whom we are so proud, pointed out in his anniversary address, that such a man of eminence as Dr. Philipp Lenard, Professor of Physics at Heidelberg, made the following savage outburst: "Down, then, with all considerations for England's so-called culture. The central nest and supreme academy for all hypocrisy in the world, which is on the Thames, must be destroyed if the work is to be done thoroughly. No respect for the tombstones of Shakespeare, Newton, and Faraday!" We English can never forget such desecration of the use of language. The psychology of mind of one—a scientific man, trained in science—who could descend to such depths is hard to understand. During the whole of this terrible crisis in human affairs I cannot remember ever having heard a single bitter word uttered by Englishmen in regard to Germans of the eminence of Goethe, Schiller, Wagner, and others.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Exports in War Time.—The dependence of the textile trades upon the export markets is traditional, and it is of a certain interest to note how their goods have fared, relatively to all others, in the general fall recorded in the returns for last year. In 1913, when exports of British manufactures were £411,000,000, textiles and apparel formed 48 per cent. of the whole. Last year, when the total was down to £292,000,000, textiles and apparel formed a proportion of substantially 50 per cent. It should be of some consolation to know that the relative position is no worse. A point that takes the eye in a general survey of the details of the export trade is the smallness of the loss in direct trading with the hostile countries. Measured in yards the shortage of the exports of cotton piece goods is 2,327,000,000, in comparison with 1913. A trifle over 3 per cent. is all that is ascribable directly to the stoppage of sendings to Germany, and although there are 350,000,000 yards less to Turkey, even this item is small. The reduction of 1,150,000,000 to India and of 341,000,000 to China, and the all-round decreases to the South American markets are appreciably more to the point. Where, as in the case of worsted yarn, the cessation of German buying would seem superficially of great effect, the simple fact is that in the prevailing conditions the absence has not been missed.

A Substitute for Acid.—It is perhaps a tribute to the economy of the previous management to say that the war has disclosed remarkably few opportunities of substituting waste products for supplies that have grown unwontedly scarce and dear. Under stronger pressure it is conceivable that more of the second-best might have been brought within the range of practice, and the absence of striking instances cannot be altogether a matter of regret. The absorption of sulphuric acid by the munitions factories has accounted already for a rise to three or four times the accustomed price of brown oil of vitriol, and the commodity promises only to become more scarce. Those who have used sulphuric in dyeing and bleaching, the carbonisation of rags, and the recovery of grease from washing waters, are under the obligation therefore of considering anything that can be used in its place. An alternative to fluid acid has been found in the spoil heaps of the nitric acid maker, whose nitre cake remaining after the treatment of Chile saltpetre becomes a nuisance to himself. The cake contains 30 per cent. of sulphuric acid, and is a dripping mass inconvenient of transport and more difficult of handling than common vitriol. The material has, however, been satisfactorily substituted, and is capable of use upon a larger scale, granted that certain steps to organise its supply and distribution are taken. These measures have the attention of the Ministry of Munitions and of committees of consumers, and it is altogether probable that nitre cake will be brought into more general consumption.

The Fly-shuttle.—It was in 1733 that John Kay, of Bury, obtained his patent for the fly-shuttle propelled by a jerk across the loom in place of the instrument that had to be thrown across by hand. The invention liberated one of the weaver's hands, accelerating progress by giving him time to beat home the reed, and the picker is incorporated, of course, in the power loom. It must give some people a shock to realise that there are still parts of the world in which this improvement is imperfectly appreciated and not universally adopted. With a view to securing a wider recognition of an improvement which is no secret and not in doubt, the Government Weaving Institute at Benares has been arranging a series of public demonstrations for the conviction of the hereditary weavers in the United Provinces. Matches between local weavers and students using the fly-shuttle have been held, with the effect that they have been shown that wider cloth can be woven, that three to four times the length can be produced, and that yarns as fine or finer can be used. These arguments may be thought insuperable, and the conversion of local opinion should follow as a matter of course. The fly-shuttle has been seen beforehand in the same quarter, but for the reason that in the schools the looms were worked upon two-fold warps the suspicion had spread abroad that they were useless upon any other.

The Dislocation of Transport.—The disorganisation of inland transport is responsible for a strain upon working capital of which little has been heard, and, coming upon the top of inflated prices, the inconvenience is serious. The case is perhaps seen at its worst in respect of wool. One pound of raw wool costs as much as two pounds used to do, so that for a beginning a buyer has to find twice the money. The wool has to be paid for within a stipulated limit of time and before it can be touched. When the material is wanted it cannot be had because of the congestion of docks and railways, and the owner has to go forth and buy more, often at still higher prices, to meet his pressing obligations in delivery. More or less throughout the whole course of manufacturing there are delays arising out of the non-delivery of one article or another, and when the goods are manufactured there is at least twice the usual delay in getting them dyed and receiving payment. The necessity of keeping twice the usual stock in progress redoubles the need of money, and even the most cautious and thrifty of managers have been reduced to unknown straits in financing their transactions. The instance is only another one

displaying the effects of a ramrod introduced into the vitals of the complex machinery of commerce. All transport is disarranged, and that which most concerns manufacturers at present is the carriage of coal. Industrial consumers are paying double prices for engine coal, and are feeling that on these handsome terms they ought at least to be privileged to receive enough for their daily needs. The output from the pits has been lowered by recruitment, the munitions factories have first call on the supply, and the available balance is out of reach for want of trucks or sidings or, as some say, rational organisation of the existing facilities. Now, more than ever, manufacturers appreciate the relief that their own motor-waggons give.

Specifications for Fabrics.—Army-contracting should have done something to break down the almost invincible prejudice against working to precise specifications. It has always been obligatory to work to specified lengths, widths, and weights, but not to definite strengths, and manufacturers have been disposed to look upon guaranteed breaking-strains as devices to entrap them. The breaking-strain determined by a direct pull exerted between pairs of vice-jaws is not exactly equivalent to wearing-strength, although there is some relation between the figures. What manufacturers have preferred to do has been to quote to a pattern, treating strength as a factor variable for causes not all within their control, and relying on giving good, merchantable durability. They have not, in their ordinary trading, regularly tested and recorded the strengths of their goods, and thus have not known with particularity how the facts stand. Their experience has suggested to them that those who insist upon a guarantee pitch their standards at a height which cannot unfailingly be reached. The objection is not so much to standards as to unfair standards, and more light has been thrown upon the whole matter of cloth strengths in course of prolonged efforts to satisfy official requirements. The testing machine reveals the use of deficient raw material, and if this is of disadvantage to some it is not so to others who may be undercut in competition. Granting always that the standard fixed is one that can reasonably and consistently be maintained, there is something to be said for its existence. Deficient raw material may reveal itself to the practised eye, but not all buyers of fabrics, and certainly not all who buy on account of public institutions, are skilled in the detection of minute differences of quality.

Worsted in Japan.—It appears from the report of a well-informed correspondent of the *Far East* that extensions are afoot in the worsted industry of Japan. The present woolcombing equipment of that country is far inferior to that which can be found in many a single shed in Yorkshire. There are at present fifty-two combs, and their number should be doubled by the middle of the year. Within two years it is anticipated that Japan will be independent of all outside combers and nearly independent also of outside sources of worsted yarn. The present number of worsted spindles in Japan is the small one of 155,000, and of woollen spindles 55,000. The worsted trade has been confined to the making of *mousseline de laine*, a business that has been overdone, and that does not offer the opportunity of expansion afforded by trades which are probably no more difficult to negotiate. Japan lacks, however, the heavier looms that would be required for making general worsted fabrics.

Mill Property in France.—Where, as at Rheims, textile mills in France chance to be on the firing line the devastation of premises and machinery is complete. A consensus of private messages shows that mills within the occupied territory have at least not been torn down by the enemy. In Roubaix a couple of mills have been kept running on German Government work, and the remainder are at a standstill. The plants have been systematically rummaged for copper, brass, rubber and leather, and parts of machinery made from any of these materials have been removed into Germany. It is recorded in one case that the very pickers and straps have been taken from the looms, and in a large mill the depredations have been on a scale leading the proprietors to estimate that a good nine months would be required to restore the place to working order. The chance of a more sweeping destruction remains, and in point of disablement there is little to choose between the dismantling and outright wrecking.

GENERAL NOTES.

Sericulture in France.—The following figures, lately published in the *Journal Officiel*, show a notable decrease in the production of raw silk in France since the outbreak of the war:—

	1913.	1914.	1915.
Total number of silkworm-rearers	90,517	83,825	43,327
Quantity of "seed" (eggs) incubated, in ounces of 25 grams each*	125,678	108,943	49,182
Production of cocoons (unstoved) in kilogrammes	4,423,046	5,067,392	1,727,326
Ditto, in English lbs.	9,752,816	11,173,539	3,806,784
Value in francs	15,655,016	19,908,930	4,243,027
Ditto £ sterling	626,200	796,357	169,721

It must be observed that the silk harvest of 1914 was completed at least a month before war was declared.

Demand for Walnut Leaves in France.—There appears to be some demand for the dried leaves of the walnut tree in France at the present time. They are used largely for pharmaceutical purposes, and previous to the war were

* The ounce of 25 grams = 385·81 English grains.

supplied chiefly from the Department of Aisne, now occupied by the Germans. They are now obtained from other countries. The leaves, which should preserve their green colour when dried, are worth from 60 francs to 70 francs per quintal (from 24*s.* 6*d.* to 28*s.* 6*d.* per English cwt.).

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m. :—

February 2. — The Hon. Lady Parsons, "Women's Work during and after the War." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

February 9.—Professor J. A. Fleming, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

February 16. — S. Charles Phillips, M.S.C.I., "Paper Supplies as affected by the War." Lord Burnham will preside.

February 23.—Miss H. B. Hanson, M.D., B.S., D.P.H., "Serbia as seen by a Red Cross Worker."

March 1.—Charles Delchevalerie, "Belgian Literature."

March 8.—Charles R. Darling, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

Indian Section.

February 17.—C. A. Kincaid, C.V.O., Indian Civil Service (author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.), "The Saints of Pandharpur: the Dawn of the Maratha Power." Lieut.-Colonel Sir David W. K. Barr, K.C.S.I., will preside.

March 16.—Professor Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

Dates to be hereafter announced :—

R. W. Seton-Watson, D.Litt., "The Balkan Problem."

Rev. P. H. Ditchfield, "The England of Shakespeare."

W. A. Craigie, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

Victor Horta, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

Professor T. G. Masaryk, "The Slavonic Peoples."

G. P. Baker, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

Edward Percy Stebbing, F.L.S., F.R.G.S., Head of the Department of Forestry, University of Edinburgh, "Forestry and the War."

Sir Daniel Morris, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

James MacKenna, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

Indian Section.

Thursday afternoons at 4.30 p.m. :—

April 6, May 18.

Colonial Section.

Tuesday afternoons, at 4.30 p.m. :—

March 21, April 11, May 2.

Cantor Lectures.

Monday afternoons at 4.30 p.m. :—

J. Erskine-Murray, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

Fothergill Lectures.

Monday afternoons, at 4.30 p.m. :—

Rev. Dr. Herbert West, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "National and Historic Buildings in the War Zone: their Beauty and their Ruin." Three Lectures.

Syllabus.

Lecture I.—February 7.—*Belgian Architecture and History.* Belgium a land of cities—What makes a city (Gen. xi. 4)—Tower—Church—Communal Hall—Belgian civil architecture, commercial—Cloth Halls before Town Halls—Churches borrowed, but splendid furniture given by Trade Guilds. Ypres typical — Tournai. Rhenish. Source of Noyon—Soissons. St. Remi—French efforts to annex Flanders—The Matins of Bruges—Battle of the Spurs. Courtrai—Rivalry of Ghent and Bruges—Edward III. and J. van Artevelde—Sluys—Coucy. Pierrefonds—Mediæval sieges—Philip van Artevelde, Roosebek. Suzerainty of Burgundy—Charles the Rash and Louis XI. Dinant—Sack of Liége. Mary of Burgundy. Arras—Lierre. Charles V. and Philip II. Egmont and Horn—Louvain—Malines—Antwerp—Louis XIV. and William III. Namur. Bombardment of Brussels.

Lecture II.—February 14.—*Gothic Architecture, French and English.* The French Cathedral, a Great Hall, the centre of the city's life. The English Cathedral a Monastic Missionary settlement, independent of the city. The problem of

Mediæval Architecture, to reproduce Roman vaulting—Solved by permanent stone centrings (diagonal ribs) under the intersections of a groined vault (Vezelay, Durham, St. Denis, Sens). Buttresses necessary (Chartres, Amiens, Beauvais). The walls become screens of glass. Inside—Columns replaced by vaulting ribs running down to the ground (Notre Dame—N. D. de l'Épine, Abbeville). Contrast of French and English plans (Notre Dame and Salisbury). In the English Cathedral, horizontal, not vertical perspective sought. Beauty of clustered columns. Purbeck causes deep mouldings. Multiplication of vaulting ribs. Lierne and fan vaulting—Flamboyant and perpendicular—English and French façades—The French Cathedral is the expression of the National ideal; the English, of the National history.

LECTURE III.—FEBRUARY 21.—*French Mediæval Sculpture.* Christian art that of a new-born society rising amidst a dying civilisation—Provençal sculpture, Arles, etc., decadent—Burgundian, full of life and imagination; but Classical influence traceable all through (Vezelay, Autun, Auxerre)—XIIth Century (Avallon, Bourges, N. and S. doors, Chartres, W. front). Elongation of statues, architectural not ignorant—Individual types, elaborate detail. The sculpture scheme of a XIIIth Century cathedral (Laon, Notre Dame, Amiens, Reims). The Judgment door (Autun, Notre Dame, Amiens, Rampillon, Reims, St. Maclou)—The Virgin's door—Local Saints and legends (St. John Baptist, Rouen; St. Stephen, St. Théophile, Paris; St. Thomas, Semur; St. Nicaise, Reims)—The Arts, Virtues and Vices—The Months and Daily Life (Paris, Amiens, Rouen)—Statuary (St. Stephen, Sens—The Virgin, Paris—Chartres, N. and S. porches)—Reims, W. portals—Figures of Christ (Chartres, Amiens, Reims, Troyes, Solesmes).

The lectures will be illustrated by lantern-slides.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 31...British Architects, Royal Institute of, 9, Conduit-street, W., 3 p.m.

TUESDAY, FEBRUARY 1...Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "The Physiology of Anger and Fear." (Lecture III.)

Alpine Club, 23, Savile-row, W., 8.30 p.m. Mr. E. A. Broome, "Zermatt in Wartime."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. E. Marriage, "First Steps in Photography with the Microscope."

Rontgen Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8.15 p.m. Exhibition of Lantern Views of Gallipoli.

WEDNESDAY, FEBRUARY 2...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. The Hon. Lady Parsons, "Women's Work during and after the War."

University of London, King's College, Strand, W.C., 5.15 p.m. Mr. Sidney Low, "The War and the Problems of Empire." (Lecture I.)

Geological Society, Burlington House, W., 8 p.m.

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Annual General Meeting. 2. Mr. G. D. Elsdon, "Note on Human Milk." 3. Mr. W. T. Burgess, "Notes on Common Processes used in Water Analysis." 4. Messrs. J. H. Barnes and Arjan Singh, "Poli Oil—a New Adulterant of Ghee."

Sanitary Engineers, Institute of, Caxton Hall, Westminster, S.W., 7 p.m. Professor G. J. Fowler, "The Activated Sludge Process of Sewage Purification."

Entomological Society, 11, Chandos-street, W., 8 p.m.

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. P. M. Johnston, "Wall-Paintings in Arundel Church, Sussex, compared with similar contemporary Examples."

Medicine, Royal Society of, 1, Wimpole-street, W. Surgery Section, 5.30 p.m. Dr. F. Hernaman-Johnson, "The Use of Condensers in the Diagnosis, Prognosis, and Treatment of Nerve Lesions."

Ophthalmology Section, 8.30 p.m. 1. The late Mr. George Coats (to be read by Mr. R. Affleck Greeves), "The Cause of the Ophthalmoscopic Appearances in Amaurotic Family Idiocy." 2. Mr. H. Spicer, "Superficial Linear Keratitis." 3. Mr. W. Edmunds, "Cataract in Experimental Thyroidectomy."

THURSDAY, FEBRUARY 3...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Chemical Society, Burlington House, W., 8 p.m. Professor W. H. Bragg, "The Recent Work on X-Rays and Crystals and its bearing on Chemistry."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. A. Bone, "The Utilisation of Energy from Coal: Industrial Applications of Gaseous Fuels derived from Coal." (Lecture III.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. F. Martin Duncan, "Nature's Masonry and Nature's Ruins."

Medicine, Royal Society of, 1, Wimpole-street, W. Obstetrics and Gynæcology Section, 8 p.m. 1. Dr. W. Salisbury, "Three Cases of Labour obstructed by Ovarian Cyst." 2. Dr. F. M. Huxley, "Fatal Rupture of Bladder in the Puerperium." 3. Dr. M. Handfield-Jones (President), "Chorion Epithelioma following Vesicular Mole." 4. Dr. M. Handfield-Jones, "Clinical Aspect of the Double Uterus."

FRIDAY, FEBRUARY 4...Royal Institution, Albemarle-street, W., 9 p.m. Professor W. Bateson, "Fifteen Years of Mendelism."

University of London, Bedford College, York-gate, N.W., 5 p.m. Mrs. M. Creighton, "The State and the Church."

Geologists' Association, University College, W.C., 7.30 p.m.

Medicine, Royal Society of, 1, Wimpole-street, W. Laryngology Section, 4 p.m.

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Sir George Paish, "The Economic Strength of Great Britain."

SATURDAY, FEBRUARY 5...Royal Institution, Albemarle-street, W., 3 p.m. Sir Sidney Lee, "The Shakespeare Tercentary: The Range of Shakespeare's Influence." (Lecture I.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

NEXT WEEK.

MONDAY, FEBRUARY 7th, 4.30 p.m. (Fothergill Lecture.) REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "National and Historic Buildings in the War Zone: their Beauty and their Ruin." (Lecture I.)

WEDNESDAY, FEBRUARY 9th, 4.30 p.m. (Ordinary Meeting.) PROFESSOR J. A. FLEMING, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

EIGHTH ORDINARY MEETING.

Wednesday, February 2nd, 1916; DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, in the chair.

The following candidates were balloted for and duly elected Fellows of the Society :—

Aiken, Rev. James, M.A., St. Thomas' Manse, Georgetown, Demerara, British Guiana.

Briefer, Michael, Ausco Company Research Laboratory, Binghampton, New York, U.S.A.

Brooks, Edmund D., 89, Tenth-street South, Minneapolis, Minnesota, U.S.A.

Griggs, Professor Edward Howard, A.M., Montclair, New Jersey, U.S.A.

Hemmeter, John C., M.D., Ph.D., Sc.D., LL.D., 739, University Parkway (Roland Park), Baltimore, Maryland, U.S.A.

Howell, Hon. Clark, Atlanta, Georgia, U.S.A.

Lawrence, Thomas Richard, 5, Bellasis-road, Byculla, Bombay, India.

Monserrat, Nicholas D., Hartman Building, Columbus, Ohio, U.S.A.

Randolph Isham, D. E., 1827, Continental and Commercial National Bank Building, Chicago, Illinois, U.S.A.

Ridge, James A., The Ceylon Wharfage Co., Ltd., Colombo, Ceylon.

Sibert, General William L., Presidio, San Francisco, California, U.S.A.

Thorndike, Townsend William, M.D., 20, Newbury-street, Boston, Mass., U.S.A.

Updike, Daniel Berkeley, The Merrymount Press, 232, Summer-street, Boston, Mass., U.S.A.

THE CHAIRMAN, in introducing Lady Parsons, took it for granted that those present at the meeting were all familiar with the work of her distinguished husband, Sir Charles Parsons, in the development of the steam turbine, a work which had benefited the whole world and Great Britain in particular. Lady Parsons had given special attention to the question of women's work in war.

The paper read was—

WOMEN'S WORK DURING AND AFTER THE WAR.

By THE HON. LADY PARSONS.

The title of the paper before us, "Women's Work during and after the War," covers a very wide field. I propose to narrow it down somewhat, and speak chiefly on the work of educated women—taking, first, voluntary work, then the principal professions open to women; and, finally, some suggestions for the more extensive employment of women's brains in developing the resources of the country.

The first weeks of the war saw a great rush of women from the upper and middle classes eager to offer their services for any kind of

work, if only they might have something useful to do.

With a quick grasp of the possibilities of so much service willingly offered, Her Majesty the Queen came forward and initiated well thought-out schemes for employing all the women of England on making clothing urgently needed for our rapidly increasing armies, and for supplying hospitals with the comforts and necessities they would soon be needing for our wounded sailors and soldiers.

Other work guilds and societies followed suit, and covered distant localities that could not have been reached by one central organisation, and so well did Her Majesty's idea catch on that a steady stream of clothing kept pouring into all the depots, collected from every part of the United Kingdom.

A later development of working guilds and societies, showing a further advance along the road to efficiency and systematic supply, are the war hospital depots in London and the provinces. In the fine old Georgian mansion, kindly lent by King's College for Women, and in six other houses, some three thousand ladies are at work, and turn out each week about twenty thousand surgical dressings and other articles.

In one room some fifty ladies are making surgical swabs, using a very ingenious little machine for teazing the raw material invented by one of their number. In another room they are rolling bandages, using the latest improvement in bandage roller, also perfected on the premises; others are making hospital requisites from old linen and soft materials, sent in as gifts. Upstairs are the sterilising rooms, and in another room the articles are being packed with the neatness and precision of the professional packer. In another house all sorts of clothing are being made, to standard patterns, two rooms being devoted to the making of carpet slippers. There are, in addition, carpentering shops where are being turned out the best of splints, crutches, bed tables and rests; but this work is carried on by some hundred men over military age, who make about six hundred articles a week of a unique and well finished character invaluable to hospitals.

The interesting feature about these voluntary workrooms is that the workers are actually setting up a standard of excellence for their surgical articles; there is nothing at all of the amateur about the work, all is to standard patterns and can be repeated, and is of the best workmanship.

The extremely business-like management of these depots, and the high standard of the work produced in them, suggest the lines on which a women's factory, run by women for women, might be carried out on economic lines.

In the working-classes, one of the first effects of the war was, unhappily, the displacement of women's labour; most of the small luxury trades, such as florists, milliners, fancy stationers, confectioners and small dressmakers, either closed their businesses altogether or employed a fewer number of hands.

It was objected that all the guilds and work societies were taking the bread out of poor women's mouths, and that independent women ought to have employed their poorer sisters instead of working themselves. This did not seem to be a very sound argument, as, if carried to its logical end, there would not be any voluntary work at all, and the women of the so-called leisured classes, full of energy and very excellent business capacity, would have to sit in idleness and waste their brains in the unprofitable study of how to do nothing.

Happily after a few months of uncertainty, work became plentiful and well paid, and any temporary distress was absorbed in the general prosperity of the wage-earning classes.

Attracted by the stirring outdoor life and the movement and change, hundreds of healthy young girls are taking the place of boys as messengers, telegraph and errand girls. They ride on vans and deliver parcels, and sometimes drive the vans themselves; they conduct trams and drive taxis; they mount ladders and clean windows and street lamps; they punch your tickets and carry your luggage. That many of these occupations are blind alleys does not disturb the joyful young spirits, who find them an easy and congenial task, and, escaped from dressmaker's workrooms, will not be easily shut up again in these respectable sanctuaries.

Medical.

Coming to the professions for women that the war has brought into special prominence, the medical profession stands out clearly as the highest and most important of the professions, so far, open to women. Never before have women doctors had such opportunities for distinction and such a wide scope for their skill, and very splendidly they are responding to the calls of service.

Here in London a women's military hospital, with five hundred and fifty beds, has been at work since May. It is established in the old

workhouse (now no longer needed) of Endell Street, completely remodelled and brought up to the requirements of a modern hospital. The whole of the administrative staff are women. The medical staff consists of fourteen women, and comprises all the specialists proper to a hospital of this size. Being a military hospital they rank, for purposes of pay, from a major to a subaltern. All the surgical operations needed for the wounded soldiers are done in the hospital by the women surgeons. The hospital is under exactly the same inspection, and no other, as any of the other military hospitals.

Certain pleasing touches show the great interest taken by professional women in this, the first military hospital to be staffed by women. Such, for instance, is a very complete library for the use of the patients and general staff. Some of our favourite authoresses give their services as librarians, and personally advise the patients in the books most likely to please; and many of the most popular actresses in London form the committee of the entertainments.

Medical women are able to specialise in the different branches of surgery or medicine that most appeal to them. One may prefer research work, another may be successful in the treatment of nervous complaints. Some few women are specialising in the several branches of X-ray work. This needs a further and varied training. The operator must have a practical knowledge of electricity to put up and keep in order the apparatus; and she must be a good photographer to understand and develop the shadowy negatives. One medical woman, who has spent her life in the most accurate scientific observation, is able to localise a piece of metal to its exact depth and position in the wound; she is able to tell the surgeon whether the bullet is accessible or not, whether it is in a position where damage may be expected, or whether it may safely be left; and in thus saving many a wounded patient from unnecessary pain she finds a fitting crown to a life spent in unobtrusive study.

The Scottish Women's Units in France have set up a standard of efficiency that completely astonishes the French medical authorities. The large unit at Royammont carries on a fully equipped military hospital under the French Red Cross.

The story of the units in Serbia, and all their hardships and sufferings and their terrible experiences in crossing the mountains, is gradually being related by members who have been lucky enough to arrive home, and makes a thrilling page of history.

It is very remarkable that although French medical women are very highly skilled, and have been admitted to study in all the general hospitals for several years, they have not been allowed, in one single case, to set up as a unit to give medical assistance to their own countrymen. The French medical women are themselves extremely distressed (not unnaturally) at the preference shown to British women surgeons, while they, in their own country, have to accept subordinate positions. The conclusion arrived at between the medical women of the two countries (in friendly conversation) seems to be that the English medical women owe their present better position to the fact of having a medical school entirely managed by themselves, where all the responsible positions, the administration, finance, the lectures, and the entire business of the school are carried on by themselves. Thus they have useful experience, and learn how to deal with people, how to take responsibility, and how to fill important positions.

The status of medical women is greatly strengthened at the outset of their career by having a strong well-established institution behind them, such as the London School of Medicine for Women; an institute that can take up on behalf of the young doctor any professional difficulties that may arise, any trouble as to salary or status, or any of those disputes that are always liable to come up in any profession.

Now that the number of women medical students has increased so largely, it is most essential that the London School of Medicine for Women should be brought thoroughly up to date. It is being enlarged, new laboratories and lecture rooms being essential for the accommodation of all the new students. In the absence of so many medical men called to the service of the army, and so few young men taking up the medical profession at present, the woman doctor is becoming a very real necessity to the country. Although the value of the medical student is prospective rather than present, it would be a great mistake on the part of the public to let the important years of study and clinical practice suffer curtailment for want of adequate support.

Musical and Theatrical.

In pleasant co-operation with the medical women come the artists of the musical and

the theatrical world, equally intent on restoring the soldier to health, vigour, and happiness, though by different methods.

The theatrical concert parties, given under the auspices of the Ladies' Committee of the Y.M.C.A., are playing an important part in the treatment of nerve troubles at the front. The parties go out for a fortnight at a time, they give generally three concerts a day, the concerts always last two and a half hours, and there is never any interval. In the huts of the Y.M.C.A. wherever they are built, in the rest camps of all the area where troops are, in camps of remount men, of ordnance and of motors, in artillery parks, in forage depots; wherever men are suffering from dullness and consequent depression, the concert parties come and cheer them; and in other huts and camps, and in hospitals where men have been recently in the trenches and under shell fire, and cannot throw off the feeling of strain, or forget the sights and sounds they have experienced, the music comes as a peaceful interlude, and often brings back sleep to those who cannot rest.

One hardly needs to comment on the generosity of the artists, because it is thoroughly characteristic of the musical and theatrical world to give freely of their brilliant talents; but it is a kindly and noble work of busy professional women, to undertake all this hard work and personal inconvenience at the minimum of expense.

Nursing.

For general popularity, the nursing profession stands high at the present time. The average man considers this an entirely suitable profession for every woman, and consequently offers no real opposition to a certain amount of training for it. Indeed, it is accepted as an axiom that every woman can nurse the sick, as it is accepted that every man can fight the enemy. In war time the nursing profession is suffused with a special glamour. The vision of giving first aid to soldiers on the actual field of battle rises before our exalted imagination, and fills the mind with vivid pictures of the highest personal sacrifice.

But the fact of the high organisation of our military medical and nursing services prevents the realisation of any such romantic dreams. The magnitude and the horrors of this war, and the immense number of casualties, seemed to the War Office to make it undesirable for the services of women to be used near the fighting lines. In France and Flanders the advanced dressing stations have been the work of the men surgeons and dressers, and the women nurses have worked in the clearing and base hospitals, trains and ships. Only with the armies of some of our smaller but most gallant Allies have nurses had the chance of rendering real first aid. With the Belgian army at the beginning of the war, several parties of women were working close up to the lines, and recently with the indomitable Serbians several of the Women's Units have been the advanced dressing stations.

The training for a nurse in the higher branches of this profession, such as a sister in the Imperial Military Nursing Service, is thorough and methodical. She must have a three years' training in a general hospital and fulfil other qualifications before being accepted for a military hospital. Then she is gazetted into the army, and her name appears in the official Army List.

The Territorial Nursing Service is much younger, but just as thorough and on the same lines as the regular service. With their excellent county organisations, and owing to their splendid routine work, the Territorials were able to complete their mobilisation in a very short time, to call up their three thousand trained nurses, and to organise a large number of auxiliary hospitals.

Their system of training being established, it was comparatively easy to expand, and take in the innumerable trained nurses from civil life who were anxious to give their services as soon as war broke out.

Among amateurs, none have been more quick and ready for service than the Voluntary Aid Detachment of the Red Cross. From the first moment of war, many detachments mobilised, and were ready with emergency hospitals (often improvised out of schoolrooms, to the entire satisfaction of the scholars), they were complete with nursing staff, beds, kitchens, and ambulance, fully equipped and only waiting and anxious for patients.

In the innumerable hospitals that the war has called into being in every corner of Great Britain, educated girls are cheerily doing their best, learning methodical habits, submitting to discipline, and working loyally together, habits that must be useful whatever the future may have in store.

Agriculture and Gardening.

Some considerable attention has been given lately to schemes for the training and employment of more women in agriculture. This world-wide industry varies so much according to local

habits and customs, it is impossible to make any general observations that would be correct for the whole of Great Britain. The agricultural population is rooted to its methods, and views any innovation with horror. One can only safely say that in places where it has always been the custom for women to work in the dairy, the byre and the fields—as in most parts of Northumberland—women are, at the present time, in considerable demand, milkers especially earning good wages. But the women employed hitherto are always of the agricultural class; no more training is required than what they pick up on the farm; hoeing the crops, picking off stones, haymaking and harvesting, are the usual field of operations in the North.

The shepherd on the Cheviot Fells treats with scorn any suggestion for women's help with his arduous duties. The work of dipping several hundreds of sheep and of shearing them, he considers far beyond a woman's strength; but hardest of all is his winter's work. He must make his daily rounds throughout the winter's storms, plunging through the snow-drifts and over frozen pools and see all his flocks collected in some secure fold or natural coombe, safe from the gathering snowstorm. Sometimes he fails, through exhaustion, to reach home, as once last winter, when the shepherd and his dog were found in the morning frozen dead in a snow wreath, the master's coat round the body of his dog.

In the southern counties, several training centres are established for giving courses in various branches of agriculture. It seems to be accepted that the girls who take these courses are from the educated classes; those girls who have been at modern schools, and have learnt all sorts of out-door games and have imbibed a healthy love of fresh air and exercise are the most promising recruits for farm work. The cottager's daughter from the country village prefers to go into a factory and do repeat work.

As gardeners women are earning good opinions. Perhaps the ideal situation for a woman is where she can work as improver under an experienced head gardener, and where the digging and other very heavy work can be done by a labourer. In such a garden she learns thoroughly and very quickly all the mysteries of potting, pricking out, of propagating and sowing seeds, under the best conditions of soil and weather, and the general routine of a good garden.

Another favourite post is as a special rockery gardener; she must dispose the little miniature crags and precipices and lay out the rocky pathways, she must place the stepping-stones to give reality to the little watercourse cunningly brought in by a pipe; then she must make a special study of the capricious tastes in soil and aspect of the fascinating little Alpine gems that love to grow amid these miniature crags, and when she works in the right spirit an educated girl has plenty of scope for her artistic tastes.

Clerical Government Work.

In all Government offices, hundreds of women have been taken on to release young men to join the colours. Girls with a knowledge of several languages, and a general grip of affairs, are employed in such interesting work as censoring, and for indexing and registration. In the War Office and at the Ministry of Munitions, the majority of the clerks now are girls, and at the Admiralty those who have had some training as art students are quick at learning to draw and colour, to enlarge and reduce the innumerable maps and charts required in the Service.

The Board of Trade has recently taken a new departure and appointed a university graduate as chief woman inspector at a high salary. In fact, broadly speaking, university girls are gradually being engaged as forewomen, supervising clerks and inspectors wherever large numbers of women are employed by Government.

Engineering.

A new field for women's enterprise seems likely to develop in the important industrial profession of engineering. In the munition areas new factories are springing up, and old firms are changing their plant and adapting their machines to munition work.

In all of the larger factories thousands of women and girls are employed. In one type of factory the girls are handling the heavy shells, placing them in the lathes, rough turning and centering them; in another shop they are engaged in the slightly more skilled work of engraving. In another factory one hundred girls will be feeding cardboard into machines, to be rolled up into cylinders for star and flash lights. Another hundred will be stamping out metal cartridge-cases in various stages of completion, others will be gauging the cartridge-cases, their nimble fingers moving at lightning speed. In another factory they are assembling all the various intricate portions of the fuses, and in a somewhat more distant shop they are filling shells and hand-grenades with high explosives.

Most of this work is what is technically called unskilled or semi-skilled work; but as the demand for munitions continues to be urgent, and the supply of skilled mechanics more scarce, it is to be hoped that employers will begin to single out some of the clever women for positions of greater responsibility and that some of them will have a chance of further training.

Where so many thousands of women are working in one firm it would be a great advantage if provision could be made for some educated girls to go through the shops and gradually take control of the unskilled women workers.

In most large works the comforts and convenience of the women are admirably attended to within the factory, excellent hot dinners are served at a price that can only just pay the cost of materials, while hospital rooms and rest rooms are often provided.

In some of the smaller firms engaged on experimental work, some educated girls are already proving to be the most useful of skilled helpers. Some can be seen soldering metal parts together, others heating and bending light brass tubing, using the roarer and picking up the little tricks of tools of old hands. Some are drilling holes in brass castings, and shaping special parts for adjustment on their corresponding frames. Some few are even beginning to set the tools in the lathes, an operation requiring great skill and experience.

Difficulties of housing are keeping educated girls back from starting on a larger scale in this profession. Existing works have grown up amid surroundings one must bluntly describe as barbarous, and the new factories are rushed up so hurriedly to meet the urgency of the call for munitions that they have got ahead of the accommodation.

It is quite evident that if girls are keen to go into engineering at a time of stress like the present, they must take things as they are; but at the same time, when one considers the enormous number of women employed on munitions, nineteen thousand, to meet the extreme needs of the country, it cannot be thought unreasonable to press for some facilities for those who have had an expensive education as well as for the unskilled women.

A roomy hostel with civilised interior arrangements and meals decently served is the accommodation most comfortable and convenient tor girls.

Once the problem of lodging is solved, educated girls would not be long in setting to work to learn the routine of the shops, and then be ready to take advantage of such opportunities as may happen.

But there must be a reasonable chance of employment at the end of the training. Professional women cannot generally afford to give themselves a course of training unless it is for some definite object.

In engineering, as in medicine, few young men are entering the profession at present; but, so far, little provision has been made to supply their place with trained women.

The aeroplane factory would seem to possess great advantages for the training of women. A great deal of the work is very delicate and light. The lathes and drills are much smaller than those used for shell work, there is little repeat work, so that an intelligent girl would have a chance of rising to a better position if she showed mechanical skill.

The motor industry is perhaps the most accessible of the engineering professions open to women. Several enterprising firms hold special classes for women, where they are taught all the mechanism of the motor, learn to do repairs, and the care of the engine and body. Their classes are very well attended, and the workshops attached extremely popular, thus showing the readiness of girls to apply themselves to mechanics when they get the chance.

As drivers of many sorts of public cars, and of hospital ambulances, women are making a great success, and as drivers of private cars they are developing a new sort of service, as they are often able to combine the duties of driving the car with some other service useful in a household, such as secretary, reader, or gardener.

A good lead has been given to engineering for women by the plucky and patriotic action of the week-end lady munition workers at various large firms. At one firm some three hundred ladies go down and keep the lathes running on Saturday and Sunday. The output of some of the ladies has created great astonishment among the ordinary workers and the skilled foremen. Already some of them can set the tools in their lathes, and some of the most skilled are quietly qualifying themselves as mechanics, the idea being for the week-end women munition workers to bring their own skilled women mechanics with them; they would then be no longer open to the charge of keeping skilled men mechanics waiting on them on Sundays.

A pleasant feature is the good understanding that exists between the regular worker and her Sunday "relief"; the position of each is quite defined and consequently there is no friction.

Prospective Work.

If a favourable opportunity were to arise for establishing a factory for women, it would be a great step towards organising all our resources. A building such as one may find in the immense and expensive workhouses that used to be built, some few years ago, and are now happily not required by the poor, would be capable of housing the educated women workers needed in the factory. In the surrounding grounds, convenient and not too large workshops would be erected. The shifts would sit down to civilised meals in the ample dining-rooms of the building. The lavatories and bathrooms, thoughtfully provided for the paupers, would at last be appreciated and enter on a career of usefulness. The large hall, often an architectural feature of the workhouse, would be utilised for simple lectures on elementary mechanics, the uses of tools, on shops management, the assembling of tools and other subjects connected with the particular industry in hand, the object being to provide a quick emergency training.

The drawing offices too, would be conducted on commonsense lines; the girls working in them would have a chance of learning something of the uses of the drawings they are tracing.

It would not then be possible for a conscientious girl tracer to waste her time on diligently tracing in a knot in the wood of the board on which her work is fixed.

The work to be undertaken would preferably be of a small and not too heavy type, needing moderate sized lathes. The special work would be determined by what seemed to be most suitable for a women's factory; it need not necessarily be munitions of war.

It would be a happy idea if the women's firm were to specialise on making some of the innumerable articles that we have bought from Germany in increasing quantities till war broke out and stopped this supply.

Motor-cars, cycles, and parts	£1,479,000
Electrical machinery . . .	£721,000
Sewing-machines and parts .	£117,000
Cheap clocks and watches . .	£200,000

are some of the most common importations from Germany.

The cost of establishing a factory on these lines is outside the scope of a private firm or even of—at the present time—a company, on account of the difficulty of getting machinery, and it is clearly a case for the Government to give a lead and make some provision for future needs.

While young men are using their best energies in fighting the enemy, and elder men are using up their brains on inventing machines for his destruction, it should be made possible for women to begin a careful study and preparation of the business methods to be followed after the war is over.

I have ventured to make these suggestions because the Royal Society of Arts has always been kind and considerate to those who have some favourite scheme to propose; and the recommendations of this Society carry so much weight. I am not without hope of having some practical suggestions as to the best way of establishing a factory on these lines.

I wish to thank the ladies who have given me so much information as to their own professions. If any incorrect statements have occurred they have arisen entirely from my own inability to give the right value to some professional matters.

DISCUSSION.

Dr. Florence Stoney wished to thank Lady Parsons for her very interesting paper, which opened up great possibilities for women's work. She had been specially interested in what was said of the engineering profession as a sphere for women. She had very little knowledge of engineering work, but she understood that women were only employed in simple and lowly-paid work, and that all good posts were kept entirely in the hands of men, chiefly owing to Trade Union troubles. She hoped that matters would soon be improved in that respect. She was especially interested in medical work, in which women had great opportunities. The demand for women surgeons was becoming much more urgent, but the means of educating women students were very limited. There was only one general hospital in London open to women students, and that had less than two hundred beds. In the Women's Medical School there were more than two hundred students, and there was a great difficulty in women getting full clinical work, while the men's schools complained that they had not enough students to do the work. She knew of one hospital where one student had seventy cases at a time in his own charge, and though he could not properly do the work yet women were not allowed to come in and help. In all London there was not a single hospital amongst the old-established institutions which would afford a woman a chance of working on the staff. Even in hospitals devoted to sick women (except those which had been specially founded by women), although all the patients were women, a woman was not permitted to work on the staff. There were other professions which might be opened up to women. If women were incapable they would not be employed, but why should they be shut out from the profession of barristers,

solicitors, and accountants? No woman was allowed to drive a taxicab in London though she might drive her own private vehicle; women were driving cabs in other towns quite satisfactorily. She had no doubt many women would be grateful to Lady Parsons for her suggestion with regard to establishing a factory for women.

MISS F. M. GLADSTONE said Lady Parsons had not mentioned a very large number of openings for women in connection with voluntary work. There were now very large organisations growing up, such as the Women's Patrols, which had over two thousand members enrolled, and were doing useful work, so useful that probably the sphere of women police would be enlarged. There was an enormous number of women working in connection with the Y.M.C.A. in canteens and in promoting concerts. Women were so keen on such work, although it was very tiring, that there was a waiting list of between 500 and 600 names of ladies in London who wished to do the work. There was no shortage of women workers in that direction. She had heard that at Messrs. Vickers' engineering works one woman had so qualified herself that she had been given the position of a forewoman.

DR. E. STONE MILESTONE said that if women could do work, and do it well, they should be given equal pay to that which had been given to the men who had done the work hitherto.

DR. WILLIAM GARNETT said he had been interested a great deal in the efficient work that had been done by ladies in very many capacities, and wished to take the opportunity of expressing his thanks to Lady Parsons for the valuable information she had given in her paper. There were two capacities which had occurred to him in which ladies could render very valuable assistance. The first was in engineering departments, in gauging work as it came from the machines. Such work depended quite as much upon touch as upon sight, and that fact pointed to ladies as specially qualified for that class of work. Secondly, there was great scope for educated women in chemical laboratories, and he expected to find a very large amount of work for women in the preparation of drugs.

THE CHAIRMAN (Dr. Dugald Clerk) expressed his indebtedness to Lady Parsons for her summary of women's work. She had mentioned many lines on which advance could be made. Woman had behaved so magnificently during the war—as indeed she had always behaved—and had developed so many unexpected qualities, that her sphere of work was being enlarged. He quite agreed with Lady Parsons that there was a great field in engineering for women. At some works he was interested in in Manchester, on Tuesday—knowing that he was to be at the meeting that evening—he inquired how many women were engaged in shell-making, and found there were about fifty, and that accommodation was being provided for 150. A few of the women there were educated women, one being a vicar's daughter, who worked as skilfully as any man. He thought Lady Parsons had rather under-estimated the number of women employed in engineering. One factory in which he was interested employed, about fifteen years ago, 1,600 women, and he was informed by one of the directors that there were now some 6,000 women altogether. Gauging had long been a woman's speciality. At such a place as Kynochs, where they made a very great number of cartridges, women were very largely engaged. Every one of the cartridges had to be accurately gauged, so that it should not jam in the Maxim or fast-firing gun, and women had been employed on that work for twenty-five or thirty years, and great numbers were working in cartridge factories now. Their hands moved so fast on the gauges that one could hardly see them. They also were employed in turning cartridge-cases, and on some of the larger work hitherto performed by men. He noticed that in many works now women were working upon 3·3 high explosive shells, and in some cases on 4½-in. shells. Their work was extremely accurate, and their previous experience in gauging served them in good stead. It might be said of modern engineering that it was factory engineering. In the old days a great many separate machines were built up and individually fitted for screwing, chipping, filing, etc.; but nowadays, to make a factory pay, there had to be an immense amount of repetition work, and every engineering business was so managed as to divide all the working parts up, so that one man might be making piston rings for a year, another man cross-head pins, and so on. Women could now come in and learn one particular process, and do it as well as any man. With regard to the suggestion for starting a women's factory, to-day every engineer had to know something of commercial work and make things pay. Lady Parsons' husband was a commercial engineer as well as a distinguished technical engineer. The first necessity for an engineer was to keep out of the Bankruptcy Court, and that was not so easy as it looked. What between various restrictions, different people wanting goods very cheaply, and workmen wanting all the profit, it was rather a difficult task. He would be delighted to see ladies starting works and keeping out of the Bankruptcy Court. His experience showed him that his wife was a better business woman in many things than he was a business man, but still he would not like either Lady Parsons or Mrs. Dugald Clerk to be exposed to the difficulties of handling big works. Government shell factories were another matter; no doubt there was a very large field for women there, and the field would increase. He believed that far more work would be found for women after the war than there was before, and he was glad to find at the different works with which he was connected the prices paid to the women for piece-work were practically the same as those paid to the

men. There were some works where manufacturers were strongly tempted by the cheapness of women's labour, and were inclined to use it to displace men's labour, but it involved a political-economical difficulty. No' doubt, however, that difficulty would be overcome. The total income of Great Britain just before the war was something like £2,400,000,000, but only a little over £1,000,000,000 represented actual goods manufactured, the remainder being paid for professional and other services, selling, carrying, banking, etc. If women could be brought in he had no doubt the country could be made vastly more wealthy. The Trade Unionists were afraid of women because they believed they would reduce the standard of living, but if things were treated in an enlightened way, as he thought they would be after the war, the output in actual things necessary to abolish poverty would be greatly increased by the employment of more women, especially in the employment of men and women more in productive and less in luxury trades.

Lady Parsons, in replying to the discussion, said that voluntary work was a very large and interesting question; but she had rather dealt in the paper with work for professional women. With reference to equal wages for equal work, that was, of course, the whole foundation of the subject; it was necessary to insist on women being paid the same as men for the same work, but of course it would have to be the same work. A woman who worked for an hour could not expect the wages a man received for an hour's work unless she turned out the same amount. She did not intend to run any risk of going into the Bankruptcy Court herself, but she would like the Government to provide funds. The Government had put up large and expensive shell-works, which they would not want after the war, and it might be possible for women to take them over and make something which was absolutely necessary for the country. For instance, there were such modest things as tins. In Germany there was a large factory producing tins for foodstuffs, and such tins were very much wanted in this country.

On the motion of the Chairman, a hearty vote of thanks was accorded to Lady Parsons for her paper, and the meeting closed.

SUGAR IN 1915.

In their annual review of the sugar trade for 1915, Messrs. William Connal and Co. comment on the comparative ease and rapidity with which beetroot has been replaced by cane sugar during the year. In 1913 no less than 646,648 tons of beetroot were imported for the use of British refiners, and during the first seven months of 1914, previous to the outbreak of war, a further quantity of 217,514 tons had been received, whereas during 1915 the Royal Sugar Commission has succeeded in supplying all the wants of refiners from cane sugar alone.

It was no easy matter to time the arrival of cane cargoes in London, Liverpool, and Greenock so that refiners might never want raw material. On several occasions, it is true, stocks were well-nigh exhausted, but supplies never failed to arrive in time to keep refineries in full work.

Private enterprise could scarcely have accomplished this work, more especially during the later months, when tonnage has ruled at such an abnormally high figure, and has been almost impossible to obtain by ordinary traders. This difficulty could only be overcome by Government, which possessed the power to commandeer vessels as occasion required.

The replacing of beetroot by cane sugar involved the necessity of drawing on many cane-producing countries, each contributing its quota: from Mauritius, for example, which in 1913 only supplied the West with 20,000 tons of refining quality, 93,000 tons were obtained in 1915; but the principal sources of additional supply have been from the islands of Cuba and Java. In 1913 the entire crop of Java was absorbed by the East, but during the present year about 300,000 tons have been imported to the United Kingdom, while from Cuba about 350,000 tons have been obtained, or about 100,000 tons more than in 1914.

The wonderful fertility of Cuba is well known, and it is of interest to observe that, while in 1895—the year of the Cuban Insurrection—its crop of sugar had diminished to about 200,000 tons, it has since increased year by year by leaps and bounds, until last season it has amounted to 2,592,667 tons; and the crop now commencing is estimated by Mr. Himely at 3,175,000 tons, and by Mr. Guma at 3,183,628 tons, or about 600,000 tons more than that of last season. The flow of capital into that island under American control and the preferential treatment accorded by America to Cuban sugar have contributed to this development, and the enhanced price now being obtained for this large sugar crop should enable planters to acquire the most up-to-date machinery and encourage them further to extend cultivation.

The same may be said of Java, where in 1900 the crop was only 700,000 tons, but has now reached 1,300,000 tons, and where sugar in normal times can be produced at a minimum cost.

Our own West India Crown Colonies, in which the sugar industry, not having enjoyed the same fostering care bestowed upon Cuba, has long been on the verge of extinction, have now an opportunity of resuscitation. Estates, which three years ago only realised about 10*s*. f.o.b., for their crystallised sugars, can now obtain fully 5*s*. net per cwt. more. This should impart new life and vigour to planters who have so long and so courageously fought against adversity, caused largely, for many years, by unfair competition of Continental bounty-fed sugars.

PRICES OF CHEMICALS.

The annual report of Sir S. W. Royse & Co., Ltd., states that during the closing months of 1914 there was some reaction in values of a number of articles which had advanced too rapidly after the outbreak of war. Soon after the opening of the new year, however, a general advance in values commenced, which has, with some few exceptions, been continuous throughout the year. Sulphate of copper commenced the year at £22, and was £27 10*s*. in September, since when there has been a remarkably strong and steady advance to £45 per ton, mainly through short supply of vitriol; demand latterly has been active, but lower prices are quoted for delivery after February. Exports during the months January–November are 62,549 tons, value £1,537,950 against 74,751 tons, value £1,681,955 in the corresponding period of 1913. Green copperas was fairly steady until the middle of the year, since when there has been a heavy advance in value, production having considerably decreased. Lead salts have had a continuously strong market; the production of English white sugar of lead has increased, and price has advanced from £36 in January to £69 at present, mainly through increased cost of acetic acid. Nitrate of lead has at times been quite difficult to obtain, through shortage of nitric acid, and has advanced from £30 in January to the present value of £63. Litharge and red lead have advanced steadily, excepting a slight break in May, and are £14 per ton dearer, with makers heavily engaged for some time ahead. Grey acetate of lime has been very active, and, commencing the year at £9 10*s*., advanced to £18 in June, and since to present spot value of about £32, with very little offering. Brown acetate of lime has advanced similarly, and is scarce. Acetate of soda has advanced from £21 in January to £50 at present, and only little offering; the British production looked like being considerable, but some months ago was reduced for special reasons. Carbonate of potash advanced from £40 in January to £180 in July, but many consumers ceased to buy, and it has since declined to present value of £150, although offering only in small lots. Caustic potash rose from £48 in January to about £250 recently, but for some time quotations have been merely nominal, the market being practically cleared. Montreal potashes were £55 in January, and are now £150, and very scarce. Carbonate of ammonia was advanced from 3¾*d*. to 4¼*d*. in March, and to 4½*d*. in June, and has since been steady. Salammoniac rose from £49 to £52 in April, and to £55 in October. Muriate of ammonia has varied but little, the consumption for galvanising being less than usual. White powdered arsenic from £18 10*s*. fell about £2 per ton by the end of June, and then with a pronounced shortage rose rapidly to £30 in November, and is steady at £29 at present. Borax has always been selling steadily, and has advanced from £18 10*s*. in January to present value of £25. Yellow prussiate of potash fell 2*d*. per lb. to 1*s*. 1*d*. in January, and has advanced at first steadily and latterly rapidly to 3*s*. 7*d*., and scarcely anything offering for near delivery. Yellow prussiate of soda was 7¼*d*. in January, 6*d*. in February, and is now about 1*s*. 11*d*., and very firm. Tartaric acid was 1*s*. 6*d*. in January, and is now 2*s*. 6*d*., with the market very firm, this season's crop of raw material being reported small. Cream of tartar was £140 in January and £190 in June, and the subsequent fall of £10 in this article against the considerable rise in tartaric is puzzling. Bichromate of soda has advanced from 3½*d*. to 8½*d*., and bichromate of potash from 7*d*. to 1*s*. 4*d*., and makers are very heavily sold over next year. Oxalic acid has been continuously scarce, and has advanced from 8*d*. to 1*s*. 2½*d*.

GRAPHITE IN INDIA.

Graphite occurs in small quantities in various parts of India—in the so-called khondalite series of rocks in the Vizagapatam hill tracts, and adjoining Chhattisgarh Feudatory States, in a corresponding series of rocks in Coorg, in the Godavari district of the Madras Presidency, in the Ruby Mines district in Upper Burma, and in Travancore. It has also been discovered in Sikkim, where a graphite vein, averaging about 13 in. in thickness, has been found about half a mile to the north of the road from Tsuntang and Lachen. The quality of the mineral is said to be good, large bulk samples having given a return of 93 per cent. of graphite. Other veins of graphite are known to occur in the area, according to the Quinquennial Review of the Mineral Production of India, but have not been examined in detail.

The graphite deposits of Travancore occur under conditions similar to those of Ceylon, which is but a continuation of the charnockite series and associated rocks of South India. Small quantities of graphite have been extracted in Godavari and Vizagapatam, but practically the whole of the Indian ouput came from Travancore, where the average used to be about 13,000 tons annually. Owing to the difficulty of working at increased depths, however, the mines were no longer found to pay, and were shut down in 1912.

ENGINEERING NOTES.

A High Masonry Arch Viaduct in France.—The new viaduct over the Tet River is a modern structure of granite masonry designed on the two-level principle with remarkable architectural effects to conform to the rock profile and the natural beauty of the site. Its masonry arches are supported on high piers, one of which is itself carried on the crown of a pointed arch below. A description of this work, which was designed by Professor Sejourne, is given by

A. Dumas in *Le Génie Civil* for November 6th, 1915. The plans show the extraordinary character of this modern construction and its resemblance to the old Roman aqueducts. It is notable in two features—the designer has spanned the lower narrow ravine by a 98 ft. 6 in. pointed arch, upon the keystone of which a high intermediate pier of the main arch viaduct is supported, and he has decreased the cost of the main arches by reducing their width to the minimum compatible with the lateral stability, and the general magnitude of the structure, by carrying the footways on an overhanging reinforced-concrete floor slab supported on cantilever beams. The height of base of rail above the river is nearly 225 ft. High massive towers serve to divide the main structure from the arch approach at each end. All four of the main arches are of the same clear span, about 56 ft., with full-centered circular intrados. Spandrel arches are used in the solid rubble masonry. The viaduct is on a grade of 6 per cent., and the approaches consist of circular arch spans about 29 ft. clear between piers, two on one side and ten on the other. The four main arches are 8·2 ft. wide at the top, which is sufficient to carry the narrow-gauge track and provide for the footways on each side by cantilever brackets. This total width of arches and piers increases at a constant batter to 13·65 ft. at the bottom of the high pier over the lower arch. This lower arch is 17·3 ft. wide at the crown and 22·15 ft. wide at the springing line, with a thickness of 8.2 ft. at the crown, and 11·5 ft. at the springing line. The maximum stress at the time of striking centres for the lower pointed arch was computed to be about 206 lb. per square inch. This decreases under service conditions to 175 lb. per square inch at the springing line, and 142 lb. at the crown. These figures increase to nearly 200 lb. and 242 lb. respectively when the temperature rises 10°, and decrease slightly when the temperature decreases. In the four main arches the maximum pressure is nearly 370 lb. per square inch at the springing, and 440 lb. at the crown. These high figures are admissible because of the excellent granite used, and the exceptional quality of the construction work. Ballast for the railway track is carried by overhanging reinforced-concrete slabs. An unusual feature is the use of spiral reinforcement in the lower sections of the cantilever beams. The designer of the structure, Professor Sejourne of l'École des Ponts et Chaussées, always lays great stress upon the architectural appearance of his bridges. The temperature stresses were computed by Professor Pegeaud, also connected with the same institution in Paris.

Railway Progress in South Africa in 1915.—The middle of the past year saw the South African railways joined up with the German system in South-West Africa, it being possible to run trains from Johannesburg to Swakopmund and Luderitzbucht, and *vice versâ*. The link between the two systems was built in record time—three miles per day. Although the Railway Department had to undertake an immense amount of additional work during the rebellion and the German South-West campaign, the year saw a further extension of the open mileage, and an improvement in many of the details of the service.

Russian Waterways.—The *Times* says, among the projects which, apart from the building of railways already decided upon, seem to have some chance of being realised within the near future for the benefit of Northern Russia, is that for the construction of a waterway between the White Sea and Lake Onega. This waterway, which would proceed either from the town of Onega or the small town of Suma on the south coast of Onega Bay, in the White Sea, and go straight in a south-west or southern direction to the town of Povjenets, on Lake Onega, in the Government of Olonetz, would give communication between the White Sea and the Russian canal system, as Lake Onega is in direct connection, on the one side, through the River Svir and Lake Ladoga, with Petrograd, and on the other, through the Marie Canal and the Alexander of Würtemberg Canal, with the Volga River system. The Imperial Russian Agricultural Society is understood to be working energetically for the realisation of this scheme, and has proposed to the Government that the construction of the canal should be left to a private company, subject to the guarantee that all State and industrial considerations should be observed. Among the benefits likely to be derived from such a waterway are the advantages and facilities it will offer to the transport of goods between England and America on the one hand, and Russia on the other. At the same time it will greatly assist both the exploitation for the advancement of industry of the waterfalls situated in those districts, and the solution of the Russian fuel problem. In connection with the latter, the Russian peat fuel committee draws attention to the vast peat deposits in the districts through which the canal would pass, and which, it is held, can supply both the northern and interior parts of Russia, as well as the Kola-Petrozavodsk railway with cheap fuel. The White Sea for two and a half to three months of the year already has connection with the other Russian water systems through the Dvina-Suchona Rivers; but owing to shortage of water in the latter this river traffic can rarely be continued beyond Kotlas after the middle of July. The traffic on the River Onega generally stops in the beginning or middle of November, and remains closed until the beginning of May, so that if similar conditions were to apply to the

new canal it could be used only for about seven months in the year.

Atlantic to Pacific: another Link in the Chain.—The first through train over the line of the Canadian Northern Pacific Railway left Montreal, Quebec, on October 12th at 5 p.m., and arrived in Vancouver, British Columbia, early in the morning of the 19th. The trip was made as an inspection of the line preliminary to the inauguration of regular service on November 1st, which commenced with a through passenger train service of three times a week. On the train were twenty members of the Canadian Senate, fifty members of the House of Commons, and thirty newspaper men. The last spike in the new transcontinental line was driven at Basque, British Columbia, 182 miles east of Port Mann, on January 23rd, 1915. The system opened its first line in Central Manitoba in 1896, and now has in operation about 10,000 miles of single track.

Electric Heating.—In a paper read before the Institution of Electrical Engineers, Mr. George Wilkinson proposed to control electric heaters thermostatically, so that rooms might be kept automatically at an even temperature. The author suggested that heaters should have a rating of not less than 1½ watts per cubic foot of room space, and of at least 2 watts in the case of rooms which have an abnormal window area or an exposed situation, or are subject to draughts and traffic. But if 1½ watts is sufficient for the coldest day, it is obviously excessive and therefore wasteful for every other day, and the crude regulation obtained by providing only one or two switches does not furnish the required control. It was also his opinion that there is a promising field for electric heating in cases where coal fires or radiators are already in use. Owing to the vagaries of combustion both these methods of heating are subject to wide variations of temperature, and the cool periods could be readily removed with little expense for current if thermostatically controlled electric heaters were fitted as an auxiliary.

Self-Starting Oil-Engine.—A horizontal four-cycle oil-engine designed for heavy duty has been invented. By using a compression of not more than 300 lb. an engine of comparatively light weight has been built. The engine bed is braced by steel tie-rods; these tie-rods serve as rails for a small device which acts as a travelling crane, thus permitting one man to replace or remove heavy parts of the engine. The fuel is atomised by means of a hydraulically operated sprayer. When started the gases are ignited by a hollow ring enclosed in the water-cooled cylinder head, which is heated by a torch burning some of the same fuel used to operate the engine. As soon as the engine has made a few revolutions the heat of the piston plus the heat of the compressed air in the cylinder is sufficient to ignite the oil. The governor is fixed directly to the cam shaft, and is so designed that in case the engine should be reversed it automatically cuts off the supply of fuel. One of the features of this engine is its principle of self-starting.

School of Practical Engineering, Crystal Palace, Sydenham.—It is very gratifying to know that, in spite of the terrible war now raging, and which has caused financial difficulties to many institutions, the above school, which was established in 1872, is to be carried on as usual (under the Principal, Mr. J. W. Wilson, M.Inst.C.E., M.I.M.E.). The school provides students of mechanical, civil, and other branches of engineering with thorough practical and theoretical instruction in the rudiments of the profession, and in the manipulation of materials, special facilities being afforded to colonial students. The success attained is borne out by the subsequent careers of many of the students; as examples may be mentioned the chief engineer of the Port of London Authority, chief engineer of the South African Railways, chief engineer for the Federated Malay States Railways, acting chief engineer of the Great Indian Peninsular Railway, chief bridge engineer of the Canadian Pacific Railway, and the city engineer, Birmingham.

NOTES ON BOOKS.

THE RARE EARTH INDUSTRY. By Sydney J. Johnstone; with chapter on the Industry of Radioactive Substances by Alexander S. Russell. London: Crosby Lockwood & Son, 1915. 7*s.* 6*d.* net.

The industrial importance of the rare earths is of the last few years, and the recent culmination of utility upon utility is almost like a romance when considered in relation to those elements which fifty years ago were often mentioned in the text-books as if they were useless superfluities of Nature; superfluities annoying to the chemist by so greatly complicating his scheme or system of inorganic analysis.

Even in the early days of modern chemistry we find Faraday and Stodart, as also other investigators, studying the effect of various small additions to steel, as, for example, chromium, rhodium, osmium, titanium or tungsten, and of all these additions that which made most for consideration and industrial trial was tungsten; yet if we turn to a typical standard text-book of some forty years ago we read in respect to tungsten steel: ". . . Experience does not seem to justify the expectations of its utility . . . A similar remark is also applicable to titanium steel"—quoted from Percy's

"Metallurgy," and to be found on page 633 of Vol. II. of Miller's "Chemistry," 1878 edition. Thus was cast aside that use of tungsten which is so fruitfully serviceable at the present time.

Of all the rare "earths" tungsten is, perhaps, the most abundant, and we need not dwell on our author's account of the recent applications of tungsten in relation to the steel manufacture, as, for example, in making of high-speed tool steels and rustless cutlery; but special mention may be made of the details given as regards the production of malleable or ductile tungsten and the means adopted for drawing it into the extremely fine wire which is required for the modern electric glow-lamp; the fulness but conciseness of the account, the numerous diagrams illustrating the stages, the numbered and headed paragraphs defining the steps in the process, and the references to patents or original papers, all conducing to make this description a notable one from the standpoint of technical book-making. An example of that culmination of utility upon utility to which we refer above is afforded by the fact that tungsten drawn wire, if pure, is subject to the serious defect of becoming crystalline and brittle after long use, but this defect can be more or less perfectly eliminated by alloying the tungsten with small quantities of still rarer "earths."

By our use of the word "earth" in the above sense, we wish very fully to endorse the title of Dr. Johnstone's book, and also the sentiment in the introduction, whereby metals like tantalum and tungsten are included among the earths. This is going back to the older use of the term "earth," as, for example, some three hundred years ago when earth, mineral, metal, and fossil all had a similar meaning, or, indeed, we may go back to the four primaries of the school of Aristotle as suggesting the respectability of the broad term, as far as age is concerned.

The narrow conception of "earths" became current soon after Black's "Study of Magnesia" (1755), and was made inconsistent when Davy (1807) proved such bodies to be merely the ores or oxides of metals. Hence our author's broad term, or reversion to the older usage, appears desirable and reasonable—at any rate, convenient.

The work is definitely practical, and as it is assumed that the reader has a good general knowledge of chemistry there is no waste of space in explaining elementary matters, but chemical details that are specially pertinent to the subject-matter are included. The scope of the work covers the practical technics relating to thorium and cerium (including full details as to mantle manufacture), titanium, zerconium, tantalum and niobium, tungsten, uranium, vanadium, also radium and its congeners; special care having been taken in relation to the bibliographical aspect, so that the reader may find himself in a position to refer to original sources, whether books, contributed papers, or patent specifications.

The appearance of the work is opportune in relation to present needs of British trade expansion; and in expressing a hope that the sale may be large we indirectly imply our high opinion as to the sterling qualities of the work, as also our appreciation of the laborious care on the part of those concerned—Dr. Geoffrey Martin, who edits Messrs. Crosby Lockwood & Sons' new series of Manuals of Chemical Technology; Dr. S. J. Johnstone, who is the author in the ordinary sense of the term; and Dr. A. S. Russell, who contributes the section on the industry of radioactive substances.

Standard Cloths. By Roberts Beaumont, M.Sc., M.I.Mech.E. London: Scott, Greenwood & Son. 12*s*. 6*d*. net.

In standardising cloths the two principal points to be considered are the nature of the fibrous materials used, and the various processes and methods of operation through which the cloths pass. In order to elucidate the technical scope and diversity of the subject, the author has studied collections of trade, general, and original specimens, and verified the data by experimental research; and the volume consists largely of analyses and illustrations of typical fabrics, with expositions of the principles and schemes of manufacture which they represent.

The first chapter deals with the microscopic features of woven fabrics, of which an excellent idea is given by the various photomicrographs reproduced. From this we pass to the application and meaning of the word "quality." Chapter III. gives a synopsis of cloths, and this is followed by chapters dealing with standard grades of manufacture, weaves types, fabrics light in weight and structure, medium-weight woollens, medium-weight worsteds, overcoating cloths, army and navy cloths, and finally felt manufacture.

The advantages of a standardisation of fabrics in facilitating commercial dealing are obvious, and Professor Beaumont's work towards securing such standardisation will be welcomed by workers in the textile world. The book is well got up and the numerous illustrations are excellent.

Paint and Colour Mixing. Fifth Edition. By Arthur Seymour Jennings. London: E. & F. N. Spon, Ltd. 6*s*.

The first edition of this practical handbook appeared in 1902. Its value was at once recognised by painters, decorators, paint manufacturers, and all who have to mix colours. Fresh issues followed one another, and now the book has reached its fifth edition, which completes a total issue of ten thousand copies.

Several new chapters have now been added by the author, of which the principal deal with

"Mixing and Matching Colours," "Straining Colours," "Putty Hard Stopping, Knife and Brush Filling," and perhaps the most valuable of all, "Two Hundred Standardised Colours." In this section a list is given of the colour names, with their constituent pigments.

Not the least valuable feature of the book are the plates, which have been produced with great care. They comprise together nearly three hundred specimens in actual paint of differently-named tones, and should prove very useful in establishing on a more sure foundation the nomenclature of colours.

GENERAL NOTES.

War News for West Indian Coolies.—With reference to two General Notes which have appeared in the *Journal* describing the publication in India of war news in native languages, Mr. Edward A. V. Abraham, of Georgetown, British Guiana, sends us copies of news-sheets printed in Hindi and Urdu, and circulated among the coolie population of the colony. The sheets are plentifully illustrated with war photographs, and should be useful in keeping their readers informed of the progress of hostilities.

Mine Rescue Signalling Device.—Writing in the *Coal Age*, Mr. O. Cartlidge, Manager of Mine Rescue Stations, Illinois, has described a cheap and convenient signalling outfit for men engaged in rescue work in mines. Three No. 6 Columbia dry cells are placed in the centre of a drum on which is wound 1,000 ft. of round insulated No. 16 three-wire cable. Signalling is effected by pressing buttons operating "buzzers" of the ordinary type. That at the free end of the cable is fastened to the rescuer's belt, and about 5 ft. along the wire from this is attached a stout cord, at the other end of which is a hand-grip, so that the man can pull the cable along without straining the connections; similar hand-holds are placed at intervals along the wire for other members of the gang. This apparatus (which does not weigh more than 100 lb.) has an advantage over a telephone in that the signaller does not have to attempt articulation in a suffocating atmosphere.

Ceylon Plumbago.—The loss of the German and Belgian markets was a severe blow to the plumbago mining industry in Ceylon, and steps were taken by the Imperial Institute to induce users of plumbago in the United Kingdom to purchase their supplies entirely from Ceylon instead of partly from Ceylon and partly from foreign countries, as had been their previous custom. Considerable progress has now been made in this direction, according to *Engineering*, for the percentage of Ceylon plumbago exported to the United Kingdom during the first ten months of 1915 is considerably greater than in 1913. Further, the total exports to this country from January to October are more than double those of the corresponding months in 1914, while Russia also is a large new purchaser. The principal use of plumbago is in the manufacture of steel-works crucibles, which are required to resist the effects of great variations of temperature.

The Fish Supply of Calcutta.—Though Calcutta is on a river and only ninety miles from the sea, its fish supply is poor in quantity and variety. Of the want of variety everyone can speak. The only fish with flavour which the European is usually permitted to eat is *hilsa*, which has been compared with mackerel, and is as oily as a herring. Yet there is good fish in the sea, as the explorations of the "Golden Crown" sufficiently showed. It will be remembered that the results of these investigations were described in a paper read before the Society in 1911 by Dr. J. Travis Jenkins, who pleaded for the establishment of a Fishery Board in India, and urged that it was the duty of the Government to encourage, in every way in its power, the development of this natural source of food supply. Mr. Southwell, the Deputy Director of Fisheries, has now demonstrated that the supply is far below the requirements of the population. The amount which reaches Calcutta in a year is 3,625 tons, or less than ten tons a day for a city of a million inhabitants, of whom the vast majority eat only fish when they take any animal food.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

February 9.—Professor J. A. Fleming, M.A., D.Sc., F.R.S., "The Organisation of Scientific Research." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

February 16.—S. Charles Phillips, M.S.C.I., "Paper Supplies as affected by the War." Lord Burnham will preside.

February 23.—Miss H. B. Hanson, M.D., B.S., D.P.H., "Serbia as seen by a Red Cross Worker."

March 1.—Charles Delchevalerie, "Belgian Literature."

March 8.—Charles R. Darling, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

MARCH 15.—EDWARD PERCY STEBBING, F.L.S., F.R.G.S., Head of the Department of Forestry, University of Edinburgh, "Forestry and the War."

INDIAN SECTION.

FEBRUARY 17.—C. A. KINCAID, C.V.O., Indian Civil Service (author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.), "The Saints of Pandharpur: the Dawn of the Maratha Power." LIEUT.-COLONEL SIR DAVID W. K. BARR, K.C.S.I., will preside.

MARCH 16.—PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

APRIL 27.—JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

MAY 18.—SARDAR DALJIT SINGH, C.S.I., "The Sikhs."

COLONIAL SECTION.

FEBRUARY 28 (Monday, at 4.30 p.m.).—PERCY HURD, "Next Steps in Empire Partnership."

Dates to be hereafter announced :—

R. W. SETON-WATSON, D.Litt., "The Balkan Problem."

REV. P. H. DITCHFIELD, "The England of Shakespeare."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

VICTOR HORTA, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

PROFESSOR T. G. MASARYK, "The Slavonic Peoples."

G. P. BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

ARTHUR S. JENNINGS, "Painting by Dipping, Spraying, and other Mechanical Means."

SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m. :—

March 21, April 11, May 2.

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m. :—

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m. :—

REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "National and Historic Buildings in the War Zone: their Beauty and their Ruin." Three Lectures.

Syllabus.

LECTURE I.—FEBRUARY 7.—*Belgian Architecture and History.* Belgium a land of cities—What makes a city (Gen. xi. 4)—Tower—Church—Communal Hall—Belgian civil architecture, commercial—Cloth Halls before Town Halls—Churches borrowed, but splendid furniture given by Trade Guilds. Ypres typical—Tournai. Rhenish. Source of Noyon—Soissons. St. Remi—French efforts to annex Flanders—The Matins of Bruges—Battle of the Spurs. Courtrai—Rivalry of Ghent and Bruges—Edward III. and J. van Artevelde—Sluys—Coucy. Pierrefonds—Mediæval sieges—Philip van Artevelde, Roosebek. Suzerainty of Burgundy—Charles the Rash and Louis XI. Dinant—Sack of Liége. Mary of Burgundy. Arras—Lierre. Charles V. and Philip II. Egmont and Horn—Louvain—Malines—Antwerp—Louis XIV. and William III. Namur. Bombardment of Brussels.

LECTURE II.—FEBRUARY 14.—*Gothic Architecture, French and English.* The French Cathedral, a Great Hall, the centre of the city's life. The English Cathedral a Monastic Missionary settlement, independent of the city. The problem of Mediæval Architecture, to reproduce Roman vaulting—Solved by permanent stone centrings (diagonal ribs) under the intersections of a groined vault (Vezelay, Durham, St. Denis, Sens). Buttresses necessary (Chartres, Amiens, Beauvais). The walls become screens of glass. Inside—Columns replaced by vaulting ribs running down to the ground (Notre Dame—N. D. de l'Épine, Abbeville). Contrast of French and English plans (Notre Dame and Salisbury). In the English Cathedral, horizontal, not vertical perspective sought. Beauty of clustered columns. Purbeck causes deep mouldings. Multiplication of vaulting ribs. Lierne and fan vaulting—Flamboyant and perpendicular—English and French façades—The French Cathedral is the expression of the National ideal; the English, of the National history.

LECTURE III.—FEBRUARY 21.—*French Mediæval Sculpture.* Christian art that of a new-born society rising amidst a dying civilisation—Provençal sculpture, Arles, etc., decadent—Burgundian, full of life and imagination; but Classical influence traceable all through (Vezelay, Autun,

Auxerre)—XIIth Century (Avallon, Bourges, N. and S. doors, Chartres, W. front). Elongation of statues, architectural not ignorant—Individual types, elaborate detail. The sculpture scheme of a XIIIth Century cathedral (Laon, Notre Dame, Amiens, Reims). The Judgment door (Autun, Notre Dame, Amiens, Rampillon, Reims, St. Maclou)—The Virgin's door—Local Saints and legends (St. John Baptist, Rouen; St. Stephen, St. Théophile, Paris; St. Thomas, Semur; St. Nicaise, Reims)—The Arts, Virtues and Vices—The Months and Daily Life (Paris, Amiens, Rouen)—Statuary (St. Stephen, Sens—The Virgin, Paris—Chartres, N. and S. porches)—Reims, W. portals—Figures of Christ (Chartres, Amiens, Reims, Troyes, Solesmes).

The lectures will be illustrated by lantern-slides.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 7...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Rev. G. H. West, "National and Historical Buildings in the War Zone: their Beauty and their Ruin." (Lecture I.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. C. Lias, "The Unity of Isaiah."

Electrical Engineers, Institution of (Local Section), at the South Wales Institute of Engineers, Park-place, Cardiff, 5.30 p.m. Mr. O. L. Record, "The Testing of Underground Cables with Continuous Current."

Engineers, Society of, Caxton Hall, Westminster, S.W., 5.30 p.m. Presidential Address by Mr. P. Griffiths.

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m.

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Mr. C. F. Slater, "Dilapidations—Some Notes and Suggestions."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Mr. H. C. Woods, "Communications in the Balkans."

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Hon. W. P. Reeves, "The Balkan States." (Lecture I.)

TUESDAY, FEBRUARY 8...Electrical Engineers, Institution of (Local Section), 17, Albert-square, Manchester, 7.30 p.m. Mr. O. L. Record, "The Testing of Underground Cables with Continuous Current." (Scottish Section.) Princes-street Station Hotel, Edinburgh, 8 p.m. Mr. H. H. Harrison, "The Principles of Modern Printing Telegraphy."

Asiatic Society, 22, Albemarle-street, W., 4 p.m. Professor D. S. Margoliouth, "The Islamic Pulpit."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "Nerve Tone and Posture." (Lecture IV.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. W. T. Lucy, "Notes on the Working of a Rack Railway."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Annual General Meeting.

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Professor E. B. Poulton, "On a Collection of Moths made in Somaliland by Mr. W. Feather; with Descriptions of New Species by Sir G. F. Hampson and others." 2. Professor H. G. Plimmer, "Report on the Deaths which occurred in the Zoological Gardens during 1915, together with a list of the Blood-parasites found during the year."

Colonial Institute, Hotel Cecil, Strand, W.C., 8.30 p.m. Mr. J. L. Garvin, "The British Empire and the Near East."

WEDNESDAY, FEBRUARY 9...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Professor J. A. Fleming, "The Organisation of Scientific Research."

Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Mr. E. J. Pilcher, "The Battle of Michmas."

Automobile Engineers, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. D. Williamson, "Petrol Engines for Commercial Vehicles."

University of London, King's College, Strand, W.C., 5.15 p.m. Mr. S. Low, "The War and the Problems of Empire." (Lecture II.)

Electrical Engineers, Institution of (Yorkshire Section), Philosophical Hall, Leeds, 7 p.m. Mr. O. L. Record, "The Testing of Underground Cables with Continuous Current."

THURSDAY, FEBRUARY 10...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Sir Frank Dyson, "Measurement of the Brightness of Stars—Visual and Photographic Magnitudes." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8 p.m. Professor W. C. Anderson, "Salonica and the Country Round."

Optical Society, at the Chemical Society, Burlington House, W., 8 p.m. Dr. W. J. Ettles, "Optical or Visual Signalling."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Mr. O. L. Record, "The Testing of Underground Cables with Continuous Current."

FRIDAY, FEBRUARY 11...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor W. M. Flinders Petrie, "Egyptian Jewellery."

University of London, Bedford College, York Gate, Regent's Park, N.W., 5 p.m. Professor W. R. Sorley, "The International Crisis: the Theory of the State. Lecture II.—The State and Morality."

Astronomical Society, Burlington House, W., 5 p.m.

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m. Annual General Meeting.

SATURDAY, FEBRUARY 12...Royal Institution, Albemarle-street, W., 3 p.m. Sir Sidney Lee, "The Shakespeare Tercentenary. Lecture II.—Shakespeare as a National Hero."

Correction.—In the report of Sir Frederic M. Hodgson's remarks on Mr. J. Arthur Hutton's paper, "The Effects of the War on Cotton-Growing in the British Empire," in the sixth and fifth lines from the bottom of col. 1, p. 222, for the words, "British Guiana" read "the Gold Coast."

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FRIDAY, FEBRUARY 11, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 14th, 4.30 p.m. (Fothergill Lecture.) REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "National and Historic Buildings in the War Zone: their Beauty and their Ruin." (Lecture II.)

WEDNESDAY, FEBRUARY 16th, 4.30 p.m. (Ordinary Meeting.) S. CHARLES PHILLIPS, M.S.C.I., "Paper Supplies as affected by the War." LORD BURNHAM will preside.

THURSDAY, FEBRUARY 17th, 4.30 p.m. (Indian Section.) C. A. KINCAID, C.V.O., Indian Civil Service (author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.), "The Saints of Pandharpur: the Dawn of the Maratha Power." LIEUT.-COLONEL SIR DAVID W. K. BARR, K.C.S.I., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

FOTHERGILL LECTURE.

On Monday afternoon, February 7th, the REV. DR. HERBERT WEST, D.D., A.R.I.B.A., delivered the first lecture of his course on "National and Historic Buildings in the War Zone: their Beauty and their Ruin."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

NINTH ORDINARY MEETING.

Wednesday, February 9th, 1916; DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Anderson, Frank Bartow, The Bank of California, San Francisco, California, U.S.A.

Dhari, Alakh, Oudh Commercial Bank, Limited, Fyzabad, India.

Farman, John, "Kirkholme," 16, St. James'-avenue, Beckenham, Kent.

Lall, P. C., Purnea City, Behar, India.

The following candidates were balloted for and duly elected Fellows of the Society:—

Bird, Captain Clarence A., R.E., 42, Fordhook-avenue, Ealing Common, W.

Crowther, Charles, 63, Yamamoto-dori 4 Chome, Kobe, Japan.

The paper read was—

THE ORGANISATION OF SCIENTIFIC RESEARCH.

By J. A. FLEMING, D.Sc., F.R.S.,
University Professor of Electrical Engineering in University College, University of London.

In the last forty years there has been a slowly progressive enlargement in the provision made within the British Empire for conducting and encouraging scientific research, though by no means proportional to the necessity for it.

Nevertheless, we have had forced on our attention by facts which admit of no denial that if we are to retain a leading position in the industrial world we must devote far more attention to it, and increase the degree to which we bring scientific knowledge and methods to bear upon all the problems of commerce and manufacture.

Amongst the indirect results of this appalling war we may hope that there will be some increased appreciation in the minds of the politicians who govern us of the enormous influence of scientific research and discovery, even in its most abstruse forms, on the prosperity and safety of the Empire. We have had brought home to us that this war is a war quite as

much of chemists and engineers as of soldiers and sailors. Hence, from the point of view of national security alone, we must take steps to foster scientific investigation. We shall probably never succeed in convincing the unthoughtful multitude of the manner in which the highest scientific researches affect human life in innumerable ways, but it will be sufficient if that fact is brought home to the consciousness of those who have political position and power, and if we can impress upon them that theirs will be the responsibility if they neglect to encourage it.

It cannot be too emphatically stated, however, that there are no short cuts to great national achievements in scientific work. We have first to produce the right conditions and environment for assisting genuine scientific work of an advanced character, and not merely to open up new fields of activity which can be exploited by second-rate ability. We require to produce the men and the ideas even more than the material appliances and facilities.

The public is, moreover, too prone to judge of the success or value of scientific work by the degree to which it can be immediately applied in what are called useful purposes.

They require to be instructed that we cannot produce merely the knowledge which is instantly utilisable in common life. Just as we can only convert a part of any quantity of heat into mechanical work when working as usual at temperatures above the absolute zero, so we cannot convert the whole of any scientific knowledge into useful applications; we have to create that knowledge disinterestedly, and then some applications will follow.

This practical invention is much affected by other factors, such as our patent laws, fiscal policy and wise or unwise commercial legislation. These will require thoughtful revision in view of coming competition.

The fundamental question before us, then, is the consideration of the conditions under which we can best increase our knowledge of natural phenomena, laws and materials, and place that knowledge in the form in which applications will most probably arise.

It obviously divides itself into the three sections, (1) Methods, (2) Means and (3) Men.

I. The Methods of Scientific Research.

The great bulk of all our scientific discovery and research in the past has been due to individual labour and initiative; much of it a labour of love, unrecognised at the time. Men of great genius have opened up new lines of thought or pursued private researches often with very inadequate appliances. In fact, the greater part of past British scientific research may be said to have been amateur work, not in the sense that it was lacking in the highest qualities, but only in the sense that it was pursued for the sheer pleasure and interest of it by private individuals. It was done mostly at odd times, and nearly always at the worker's own expense. The whole early history of electricity and of astronomy is a history of amateur work of this kind. From its very nature, therefore, it was disconnected. Each worker took up that particular bit of research which attracted his attention or offered novelty, and laboured at it in privacy.

In some cases useful scientific partnerships have been established, in which each worker supplied what the other lacked. Later on came the stage of committees, such as those of the British Association or Engineering Societies, in which a number of investigators united in some piece of research. Even then there has been a more or less disjointed action and want of co-operation between different associations.

This individual self-directed work is in keeping with our national character, but has its drawbacks as well as its strength.

It enables pioneers to open up new fields of discovery, but it retards our power of exhausting those fields of the full wealth of knowledge they contain.

In our research work this individuality has been cultivated to a point at which the Proceedings of our learned societies have become a heterogeneous mass of recorded researches which bear little relation to each other, though they may follow certain general groupings of subjects. Moreover, these researches are of very unequal value. In the case of some they are marked by great originality and genius, in the case of others they are of the nature of gleanings in a field already harvested by vigorous reapers.

The point then seems to have been reached at which the first attempt to organise research should be to create something more resembling an army out of the multitude of independent scientific workers. An army is not a collection of armed individuals, each pursuing his own aims and ideas. It is a complex organism in which each man has place and duty. No great enterprise can be carried out unless there is some degree of surrender of initiative and acceptance of directions from a higher command.

To carry out this principle in scientific work it appears to me that we require to a fuller

extent than we have it at present the system of scientific work done to order. This means that young investigators, and even older ones, shall be content to take up pieces of prescribed work, quantitative or qualitative, and carry it out individually or conjointly in connection with certain large plans of operation. This is something quite different from a research student conducting a piece of work, say, at the suggestion of a professor, and working it out on his own lines. There is just as much difference as between building a very small cottage to your own design and taking part in building a very large building to plans drawn up by a group of expert architects.

This conjoint or co-operative work would have several advantages. It would save much reduplication, and it would train beginners in the best methods of research. It would effect a saving of time and enable us much more quickly to reach a given point. There is much plain and straightforward research which can be carried out when its general lines are indicated to those not possessing very great originality, but yet having perseverance, accuracy, and skill.

If, however, such work is to be undertaken by those who may perhaps be called the privates and non-commissioned officers of the scientific army, then it presupposes a directing power which shall supply what I have elsewhere called the strategy of scientific research. This must, of course, come from the more experienced and able workers, and it is to them that we must look for ideas. If some men are to surrender initiative in their work, then others must give time and thought to planning the outlines of the scientific campaigns.

We need not only the regimental officers but the General Staff if there is to be effective achievement. My contention is that this specification of the main lines of suggested research is a matter which should largely occupy our learned societies, and, in particular, the Royal Society, from its broad and general character and unique position.

These societies have become, with few exceptions, chiefly paper-reading and paper-publishing societies. They accept, if suitable, accounts of self-suggested work from their members and others, and their Proceedings are, for the most part, a record of an immense number of disconnected pieces of work with but little correlation.

Their chief function should be that of affording an opportunity for carefully prepared discussions on subjects lying near the boundary of our knowledge and ignorance. Such discussions should be considered incomplete unless they led up to definite suggestions for new investigations.

The contributed papers should be considered from the point of view of their power of stimulating broad discussion or leading to suggestions for further work as well as their actual contributions to new knowledge. It is satisfactory to note that in some cases steps have been taken to approximate to this ideal. Of late years the British Association has organised and conducted joint discussions between its different sections on previously announced subjects guided by introductory papers, and this has had a most useful and stimulating effect.

The Faraday Society has also for some time past adopted the same plan. Their meetings have usually opened with a paper or papers contributed by authors especially conversant with the subject, summarising the existing state of knowledge and making suggestions for new departures.

Sir Robert Hadfield, the President of the Faraday Society, has mentioned that on one occasion no less than ten papers by authors of different nationalities were printed and circulated as a basis for a discussion.

The discussions at the Engineering Societies are frequently quite as useful as the papers on which they are started. The Royal Society still maintains the time-honoured custom of presenting at each meeting a group of papers of diverse character read in brief abstract to a very mixed audience of experts in many different subjects, by whom there is seldom any discussion worthy of the name.

Many of these papers would serve to stimulate better discussion if read before the special societies.

Having regard to the definition of the objects of the Royal Society in its charter—viz., that of promoting natural knowledge by experiment, it would probably not be inconsistent with that aim if time could be occasionally given to general discussions as to the direction experimental research should take in particular departments of knowledge, so that workers might be guided and a right direction given to their thoughts.

The chief function which any of these societies should fulfil is that of exciting the originality of experienced investigators and leading them into new lines of thought. Hence at the beginning of each session their councils should carefully lay their plans and divide up the available meetings between subjects of importance. They should secure from leading investigators introductory

papers, send out abstracts of these, and follow them up by short contributions from known specialists with the endeavour to focus discussion on essential points.

But something more than this is necessary. We have to formulate in precise detail the suggestions for future work, and bring them to the notice of those who may be able or willing to work them out.

The White Paper, which was issued last July by the Board of Education, signed by Mr. Arthur Henderson, seems intended to bring into existence some machinery for effecting this desired end.

So far as the "Scheme for the Organisation and Development of Scientific and Industrial Research" outlined in this White Paper is formulated in detail, it appears to consist in the establishment of (i) a committee of the Privy Council, which will be responsible for any expenditure voted by Parliament for scientific and industrial research; and (ii) a small advisory council, composed mainly of scientific men and men actually engaged in industries dependent upon scientific research.

The primary functions of the Advisory Council are stated to be to advise on—

(1) Proposals for instituting specific researches;

(2) Proposals for developing or establishing special institutions for the study of problems affecting particular industries.

(3) The establishment and award of research studentships and fellowships.

It would seem almost essential that in any case such council should have on it not only experienced investigators in pure science, but men of wide practical experience in technology and applied sciences.

The field of scientific and technical work is now so large that almost every scientific worker, even of great eminence, is necessarily more or less a specialist. It would be almost impossible for a council of a small number of members to include sufficient ability to deal with all the very different questions which will present themselves for consideration.

It requires expert knowledge to be able to judge of the value of a suggestion for new work. A physicist, however eminent in his own department, might be quite unable to say, from his personal knowledge, whether a certain proposal for new researches in metallurgy was worthy of attention and trial or not. An expert metallurgist might be able to pronounce it old or useless at once. In the same way a chemist, whatever his chemical knowledge, would probably be quite incapable of giving a useful opinion on proposals concerning researches in electrical engineering or telephony.

The White Paper tells us that it is contemplated that the advisory council will work largely through sub-committees reinforced by suitable experts in the particular branch of science or industry concerned on which it would be desirable to enlist the services of persons actually engaged in science, trades or manufactures.

It is clearly impossible for any single board composed of a few men, however eminent, to deal in any reasonable time with all the research problems awaiting solution in physics, chemistry, inorganic, organic and technical, metallurgy, engineering, electrotechnics, bacteriology, agriculture, etc., and the questions concerned in the recovery of our trade in dyes, drugs, glass, ceramic ware, ferro-alloys and scientific apparatus.

Hence separate bodies of experts will unquestionably be required to deal with the different subjects in order to bring to bear upon them the proper technical knowledge and to guide research on the right lines.

But now, if this is the case, the question at once arises: Why is it necessary to create a new machinery for dealing with these matters? Have we not already in the councils of our learned and technical societies, or in committees of their members, all that is required to form these boards, which might be called Permanent Advisory committees on scientific research? Why is it considered necessary to create new committees?

The proposition I submit for your consideration is that the organisation of scientific research should be a matter undertaken by scientific men themselves, and should not be taken over independently of them by a Government Department. The essential matter is that this organisation of scientific research should not become bureaucratic or academic, but should be conducted by bodies representative of the best technical and scientific opinion, and be closely in touch with the members of all the various scientific and technical societies. If these permanent advisory committees in the different subjects were elected from the councils or members of the various societies, we should have in them men who are closely in touch with those particular branches of pure or applied science. Who, for instance, can better prescribe the requirements in the way of research in pure and applied chemistry, or in engineering or

electrotechnics, than the leading members of the various existing chemical and engineering societies?

If public funds are to be administered, then it might be proper that certain of the members on each board should be appointed by the Government Department concerned, say, by the Education Department; but my contention is that the organisation work should be the work of scientific men as a whole and not any small section of them, or be carried out by Departmental officials over their heads.

In order to make my suggestion perfectly clear let me apply it in particular to the case of those learned societies especially concerned with experimental research or invention, such as the Physical and Chemical Societies, the Society of Chemical Industry, the Institute of Chemistry, Faraday Society, the Institutions of Civil, Mechanical, and Electrical Engineers, and so on. My suggestion is that each of these, if they have not already done so, should form a strong but small research committee of their most eminent original investigators in them. This selection should be determined by the votes of all the members, and regard should be taken of nothing but real originative ability, as exhibited by past achievements. There should be time limits for serving on this committee, so as continually to bring fresh young minds to bear upon the work. The Royal Society should put itself at the head of this work, and be the superior director of it all.

Suppose, then, we assume that we have created permanent advisory committees for the different branches of pure and applied science, the duty of which should be the organisation of research in their respective departments. Their first work should be to draw up as comprehensive a report as possible, pointing out the general needs of each department of knowledge and the most necessary directions of research in it.

The first report would no doubt have to be concerned chiefly with the deficiencies in the appliances and means of conducting it, such as laboratories and apparatus; also with the numbers and supply of men available for undertaking it or actually engaged on it.

Subsequent reports would then be properly occupied with the more detailed discussion of the problems awaiting investigation and particular suggestions for directions of research. Each advisory board should have its salaried recorder or secretary, who should be a scientific man with some literary attainments. Each board should, of course, have taken evidence from all kinds of experts in its own subject in drawing up its report, so that this document would then be not the mere embodiment of the opinions of a few, but the concentrated wisdom of all those engaged in the same field of work. Such reports, if made annually, would come to possess immense value and form a solid basis for suggested practical reforms.

These advisory boards would have then to be supplemented by some means for carrying out their suggestions into practice. We have to create a more definite professional status for the scientific investigator in pure and applied sciences, so as to push forward research in a more systematic and less casual manner than at present. Scientific research has to be elevated to its proper position as a profession quite comparable in importance with medicine and law.

Deferring for the moment some remarks on the special training for the work, suffice it to say that we must not only have a large increase in the number of the workers undertaking research, but must make it possible for a capable man to give himself to it by providing suitable stipends and inducements.

As far as regards pure science no plan seems better than that of creating an increased number of research scholarships and fellowships which shall enable a properly trained and competent man to give his whole time to such work and to earn a reasonable living by it.

Hitherto it has been largely done as a voluntary matter by university and college teachers in the intervals of teaching work or in odd moments and vacations. Such scholarships should run on the lines of the 1851 Exhibition scholarships, which have done good service, and should be of the value of £150 to £200 a year or more.

They should be annual appointments renewable on a consideration by a competent committee of the work done in the year, so as to safeguard against inefficiency or laziness.

The research students should not be left to do what they please, but should carry out the suggestions and recommendations of the above-described consultative boards.

It is a more difficult matter to arrange a scheme for industrial research work and to provide the men capable of doing it. Here we are directly concerned with knowledge or trade secrets which may have a large pecuniary value.

It is a common accusation that British firms concerned with scientific manufactures have not availed themselves of scientific expert assistance

to anything like the extent that Germans have done. Some scientific men attribute it to the want of foresight and insight on the part of the manufacturers, and some manufacturers assert that it is due to the unpractical character of a good deal of such scientific advice. The truth probably lies between the two.

There is a vast difference between the mere discovery of scientific facts and principles and the application of these in technology, where the prime question is cost and profit.

A laboratory chemist need take no account of the cost of fuel or time, he is concerned only with chemical actions; but in chemical manufacture a brilliantly successful laboratory reaction might be quite out of question as a practical matter merely on the score of fuel cost or labour, or the impossibility of securing a continuous supply of some material.

Hence the college training that may be sufficient to launch a successful investigator in the realms of pure science will be quite incomplete as regards a researcher in industrial applications unless coupled with a wide experience in factory processes and costs.

Then, again, there are certain difficulties in connection with industrial research that have to be considered.

Assume, for instance, that a trained scientist is taken on at works to investigate certain questions. He must necessarily be placed in possession of confidential information. Suppose that he makes some important discovery or invention of great pecuniary value to his employers. To whom will that improvement belong? The employers may say that without the opportunity to acquaint himself with the problem to be solved the investigator would have never made his discovery. The investigator might say that without his brains the employer would never have found the improvement.

Again, suppose that the scientific investigator does very little to help his employers, still, on the other hand, he may have acquired very important information which may make it inadvisable to let him place his services at the disposal of rivals.

Some of these difficulties have been mentioned in a report prepared by Mr. T. Ll. Humberstone, Mitchell Student of the University of London, issued as a special pamphlet by the Board of Education. This report deals with the scheme of industrial research fellowships devised by the late Professor Robert Kennedy Duncan for co-operation between universities and scientific industries which has been put in operation in the United States in the universities of Kansas and Pittsburgh.

Time does not permit me to quote extensively, but, broadly speaking, the plan is as follows: Men who have graduated with distinction and exhibited capacity for original research are nominated by the university as research Fellows. Manufacturers who are concerned with scientific processes are invited to state in strict confidence and in detail to the university certain particular scientific difficulties or problems in their work which they wish solved. They then enter into a contract with the university to pay for a defined time the stipend of a research Fellow and certain fees, and to give a bonus or royalty to the said investigator if the problem is satisfactorily solved. The Fellow, on his part, binds himself by contract to secrecy and undertakes to apply for patents if required on behalf of his employers and to certain other covenants. In this manner the interests of all parties are united.

The manufacturer has placed at his command the resources of university laboratories and libraries and his expenditure is strictly limited. The investigator has an inducement to do his best and a stimulus to diligence and preservation of reputation. The university is benefited, and, in many cases, as an indirect outcome of the solution of commercial problems, valuable contributions to pure scientific knowledge are obtained. The research Fellows gradually gain experience in industrial research which makes their work progressively valuable.

Some such scheme of profit-sharing is undoubtedly the fairest, and the best to couple together the interests of all parties.

It has sometimes been suggested that the State should make pecuniary rewards for scientific discoveries or inventions, but this is not a very practicable proposal. It is extremely difficult in most cases to appraise the value of a scientific discovery or invention in its early years, and in the next place there are pieces of scientific work the real value of which does not appear until long after the death of the originator.

Who, for instance, could have set a value on Faraday's discovery of induced currents or magneto-electric induction, when in ten days of intermittent work at the Royal Institution in the autumn of 1831 he gathered in new knowledge of surpassing importance to mankind? These facts had no apparent value at the time, yet their application has brought wealth in untold millions into the exchequer of nations.

I remember speaking, shortly after Clerk

Maxwell's death in 1879, with an eminent Cambridge mathematician concerning Maxwell's great paper published in 1865 "On the Dynamical Theory of the Electromagnetic Field." He told me in all seriousness that the impression produced on his mind by this great paper was, that it was one of the most exalted productions of the human intellect. Yet it was twenty years, and long after Maxwell's death, before this paper brought forth its fruit in Hertz's work on electric waves, and thirty-five years before we saw the final outcome of it in the achievements of wireless telegraphy.

How would it have been possible for contemporaries properly to give a value to that suggestive paper in terms of current coin?

I believe the only practical method of assisting scientific research is by a well-devised system of research scholarships, fellowships, and professorships, renewable annually or at longer intervals, and in any case held subject to productive work.

If we combine such a system with the above suggested advisory boards, there is a possibility of creating a workable system for the endowment and encouragement of scientific investigation which will be kept in close contact with practical necessities as well as with the most fertile regions of scientific thoughts. The important question is, then, the ways and means.

In the month of May last a joint deputation of the Royal and Chemical Societies waited upon the Board of Education, and later on it was announced that a Parliamentary grant of £25,000 per annum would be placed at the disposal of the Board for the purpose of research.

Whilst such a grant will do something if wisely expended, it can hardly be expected to carry out in its entirety any large and comprehensive scheme.

We have much leeway to make up, and a commercial competition in front of us in scientific industries which will tax our very utmost powers. The nation ought to be prepared to expend at least the cost of one battleship in the defence of our scientific industries.

Deferring for a moment the consideration of the training of the men to conduct it, we may consider in the next place—

II. The Provision of the Means for Conducting Scientific Research.

By this is meant the materials and apparatus required.

In early days these were simple and comparatively inexpensive. Much great work has been done with simple apparatus. Nevertheless, our modern scientific research requires, for the most part, costly appliances.

One rather startling experience at the outset of this great war was the discovery of the extent to which we had become dependent on Germany and Austria for these implements of research. We found that our sources of supply of chemical glass such as flasks, beakers, tubes, graduated vessels, and more complicated pieces of analytical apparatus were cut off. Also porcelain crucibles, basons, tubes and retorts, filter papers, and large numbers of research chemicals were not produced in England of the requisite quality.

Amongst pharmaceutical chemicals a very large number have been unobtainable, or obtainable with difficulty, since the war—such as salicylates, salvarsan, veronal and phenacetin.

My colleague, Professor Cushny, F.R.S., informs me that all the more complex synthetic chemicals, such as those used as indicators, stains in microscopic work, etc., have been obtained from Germany and are now unobtainable.

In physical and electrical work there has also been the same difficulty. Before the war we obtained many necessary materials from Germany which ought to have been made here. I instance such things as types of electric resistance furnaces for laboratory and assay work; cathode ray oscillographs and the proper type of electrostatic influence machines for working them; certain types of mechanical pumps for making high vacua; extremely fine wires of different materials necessary for thermo-electric ammeters for high-frequency current measurements in wireless telegraphy, and also special alloy wires for electrical resistances, and many other similar materials.

We were at one time even entirely dependent on Germany and Austria for electric arc carbons, and only the enterprise of one British firm saved the situation. We are even now in difficulties as regards some electric fittings and appliances.

As an instance of the way in which the Germans look forward and anticipate the future, we may note the case of tungsten ore. When, after prolonged scientific researches, the metallic filament electric lamp made with drawn or pressed tungsten wire had ousted the carbon lamp, and when the immense importance of tungsten-steel had been recognised for high-speed tools and magnet manufacture, German interests set to work to secure the control of sources of supply of tungsten, even within the British

Empire. One of the chief sources of supply of wolframite, an ore from which tungsten is obtained, is in Burma, which produces about one-fifth of the world's supply. Before the war the Germans used to secure nearly all this ore and carry out the reduction in Germany. Consequently, when the war broke out there were few or no reduction works in England capable of supplying tungsten or ferro-tungsten.

In spite of this extremely valuable tungsten supply in Burma, which is the largest mineral-producing province of India, the local government was not provided with any mining expert who could have advised them in this matter.

It is satisfactory to note, however, that steps have been taken to remedy the state of affairs. The Lieutenant-Governor, Sir Harcourt Butler, visited Tavoy, the centre of the industry, last December and addressed the Chamber of Mines. He urged the concessionaires to do all that was possible to obtain the wolframite required at present for the making of munitions, and represented that if private owners did not meet the British demand, concessions would be cancelled and the Government would take possession.

Nevertheless, the Germans have already provided themselves with large stocks of this valuable material, without which it is impossible to make modern high-efficiency incandescent electric lamps or high-speed cutting tools for engineering work.

This is only one out of many instances which might be quoted to show our extraordinary want of scientific foresight in allowing absolutely essential materials to be taken by Germany both before and during the war.

This partial famine in essential scientific materials and apparatus is not due to any real want of scientific ability on the part of British inventors or manufacturers. It is due to causes which are very deep-seated. For one thing, our easy-going national temperament has found it less trouble to buy from abroad than make for ourselves. Labour difficulties, our fiscal policy and other causes have rendered it difficult to compete with German prices.

Above all, the mistakes and ignorance of politicians who allowed themselves and others to believe that there was no real danger of a rupture of peace, and that Germany's tremendous preparations for war had no other object than defence against sudden attack by jealous neighbours, acted like an opiate on our spirit of commercial enterprise and dulled our instinct of self-preservation.

Meanwhile it is to be hoped we are now awake to facts, and that scientific men, manufacturers and our statesmen will unite in remedying the present serious condition of affairs.

With respect to the supply of laboratory materials, it is satisfactory to know that since the war began considerable progress has been made in manufacturing in Great Britain some of the scientific apparatus which formerly came to us in large quantities from Germany and Austria. At the outset of the war the Society of Chemical Industry and the Institute of Chemistry of Great Britain and Ireland addressed themselves to this question. I am indebted to their respective secretaries, Mr. C. G. Cresswell and Mr. R. B. Pilcher, for kindly furnishing some information.

A glass research committee was appointed by the Institute of Chemistry under the chairmanship of the late Professor Meldola, and by April, 1915, eleven working formulæ for chemical glass had been produced and distributed freely to British glass manufacturers. They include a formula for miner's lamp-glasses, a glass highly resistant to drugs for pharmaceutical ampoules and glass for X-ray bulbs. We have also made considerable progress in producing certain types of optical glass.

The simpler glass chemical vessels can now be made here at prices which compare favourably with German pre-war prices, but there is still some difficulty with the more complicated apparatus requiring stopcocks. Filter paper as good as any foreign make is now produced in this country.

Two leading hardware firms have turned attention to the production of chemical porcelain apparatus, crucibles, evaporating basins and so forth, and before long it is to be hoped we shall be quite independent of Germany.

Now the question is—are we going back, when peace returns, to the old easy-going habits of importing German-made scientific apparatus? Surely the answer is No! a thousand times No! But unless we wish Germany's crime-stained hands to take back in commerce what she has lost in war we have to create and maintain an entire scientific and economic independence of our own. For this purpose we need, for one thing, a properly complete Scientific Intelligence Department.

The different agencies, committees and institutions which have been endeavouring to supply scientific information as to manufactures should have as their resultant a single organisation, the function of which should be to collect and

distribute all possible information concerning the mode of manufacture and cost of production and information concerning the patent position, if any, of all the appliances and materials used in scientific research. Such a scientific intelligence and information bureau might need subsidising at the start, but it might be possible later on to make it self-supporting by the subscriptions of firms and persons who desired information on particular matters. Just as one can pay a fee to a patent agent to conduct a search for anticipations on some particular subject, so this information bureau should have as its object to collect and supply to its subscribers all possible information concerning the manufacture or supply of the materials and implements of scientific research. This bureau might have certain laboratories or workshops attached to it where information could be tested and specifications issued for the manufacture of the materials and appliances used in research. It should not be concerned either with actual trade manufacture or with researches *per se*, but should enable anyone to find out with the least expenditure of time the exact way in which certain scientific materials or instruments are made and under what conditions they can be produced, and to supply this information to the trades concerned who are its supporters or subscribers.

There are already the beginnings of such a scheme in the information published by the Institute of Chemistry on reagents for analytical purposes prepared by a special committee appointed by the Institute and by the Society of Public Analysts and other Analytical chemists.

There is also an association called the British Laboratory Ware Association, formed by various firms to stimulate the production in this country of various laboratory requisites hitherto mainly produced in Germany.

It is desirable, however, to avoid the multiplication of too many separate associations and to concentrate into one agency the means for furnishing all necessary information and intelligence required to make British scientists independent of supplies from enemy nations.

The means that shall be taken to prevent this nascent national production of the materials of research from being killed by subsequent German competition is a question to which our political economists and statesmen must address themselves very seriously. It is only a small part of the great problem of our *post bellum* commercial policy in relation to the British Empire and our Allies, but the consideration of it lies beyond our present purpose.

We have then to consider—

III. The Training of the Men to Conduct this Scientific and Industrial Research.

Whilst the highest achievements in scientific research and invention must always depend to a great extent on that indefinable quality we call genius which cannot be made to order, it can hardly be doubted that much can be done to foster and assist it.

The nation must be educated to see that the men with high scientific and inventive ability in it, not by any means too numerous, constitute a national asset of inexpressible value. This power, when it exists, should not be allowed to dissipate itself in a struggle to secure the means of living, but be given an opportunity for the fullest exercise and use. There can also be no question that we have it in our power by suitable methods of education to develop such nascent ability.

Our present systems of education, and particularly the system of written examinations which are dependent so much on good memory for success, do much to destroy originality.

In spite of all that has been written and said on this subject, we do not seem to be nearer to essential reforms. The object of all education is threefold: first to train character, will, and that power of selecting the best amongst various courses of action which we call right judgment; secondly, to impart necessary information and ability to do certain things well; thirdly, to develop initiative and the power of handling new problems or investigations, and a certain alertness in dealing with new situations. Our present methods of education are far too much directed to supplying ready-made and peptonised information.

The great outstanding fact in modern life is the degree to which the energies and materials of Nature are employed to overcome the difficulties created by the increase and concentration of population.

We have to make the earth bring forth her increase at a greater rate to supply the ever-increasing necessities of growing populations and the many artificial wants which have been created by progressive human desires.

Hence an absolutely essential part of any complete education is some knowledge of science, and especially of its influence on the welfare of mankind.

Yet the people we put in a position of authority over us are, for the most part, not only ignorant of science, but not even interested in it.

In our public schools we train boys chiefly by directing their attention to words in the form of the grammar and literature of two dead languages, and we neglect to give them any wide and sufficient knowledge of things—viz., the physical phenomena of the Universe in which they live.

Is it, then, any wonder that when these boys grow up and take their places in Government offices, in the Law Courts or on the Press, or any other influential position, they are oblivious to the last degree of events taking place in the world of science which have in them the power to make or destroy national industries or affect the living of large populations? The destruction of the madder industry of France and the indigo industry of India by German synthetic chemistry are now old and familiar stories.

The point, however, to notice is that the scientific chemical discoveries were not allowed to remain mere laboratory feats. They were transformed into successful commercial enterprises. The Badische Anilin und Soda Fabrik is said to have expended £1,000,000 and taken seventeen years' work in translating Baeyer's scientific synthesis of indigo into a factory process. But the result has justified the foresight of those who expended it.

In an article in the *English Review* for January by Mr. H. L. Heathcote, on the "Chemical Industries of Germany," it is stated that in the year 1896 India exported natural indigo worth £4,000,000, whilst in 1913 this had dropped to £70,000, or under 2 per cent. of the export in 1896, as the result of Germany's manufacture of artificial indigo, which began in 1897.

This is only one instance out of many which could be quoted to show the blows that can be inflicted in this industrial warfare, the weapons in which are not shot and shell, but scientific discoveries and inventions.

The supremely important question is: What are the steps we are taking to train the men who will enable us to hold our own in this commercial conflict?

It avails nothing to point out that the beginnings of many of these achievements were laid by British scientific discoveries or original suggestions.

A truth or a suggestion which is not followed out or pressed to the point at which it becomes practically productive, is like a seed which is not planted in the ground. The intellectual perception of a truth or principle requires behind it the driving force of character and will if it is to pass into the useful stage.

When Mr. Edison found the clue to success in his attempts to make a talking machine, the story runs that he locked the laboratory door and, putting the key in his pocket, said to his assistants: "We none of us leave this room until this thing speaks." When, after hours of labour, the infant phonograph uttered its first little sentence its constructors were allowed to proceed to their long-deferred refreshment. Very few people are aware of the steady pushing and expensive work which had to be done before laboratory experiments on electric waves were converted into practical long-distance wireless telegraphy.

Some people might be inclined to ask why there should be this competition and pressure to invent? What difference does it make who discovers a new fact or makes a new application?

If scientific knowledge were a mere matter of intellectual curiosity concerning the secrets of Nature it would not matter much, except for national honour, who made the discoveries or applications. But scientific knowledge has become much more than this. It has become the means of increasing national wealth, and also by which national wealth can be taken away. Again, in virtue of our patent laws, it has become possible for alien inventors to prevent us from even using in our own country in particular ways the waste products of our own industries, as in the case of certain coal-tar products.

Hence scientific knowledge can be applied so as to become a tremendous weapon of destruction as well as of national strength.

It is for this reason that we require men to be trained not merely to make scientific discoveries, but to make useful commercial applications of them which are wealth-producing or wealth-conserving in a national sense.

This requires a peculiar combination of scientific ability and commercial insight, and it is just here that Germany has the advantage.

Mr. Lloyd George said on one occasion that he feared Germany's war-bread spirit, by which he meant the willing subjection of a whole Empire to discipline. We might say, with even more truth, that what is to be feared is Germany's militant chemistry and engineering, or that combination of organised and commercialised science which is relentlessly applied without any moral restraint to undermine and take away sources of power of other nations.

This, however, is what we have to meet. We have to train chemists, engineers, electricians and physicists who are not only learned in the knowledge of their science and originative in discovering new facts and principles, but have also a keen commercial sense which directs them to the solution of the practically useful problems.

We have, therefore, to create a very much closer union between industry and science.

To some scientific men this seems derogatory to the dignity of science. On the other hand, men concerned with the business side of manufacture are apt to undervalue the aid which science can give them. Meanwhile our scientific industries suffer from this dissociation.

In the first place we should aim at bringing about a much more intimate relation between the universities and technical colleges and the factories and workshops, so that the college teaching may result in producing a type of man more useful in the factory. For this reason I am an advocate of the so-called sandwich system, by which the student spends a year alternately in the shop or factory and in the college, the first and third year being at the college and the second and fourth in the shop or factory. This turns out a better type of man than two years at the college and two years in the shop taken consecutively. It should apply not only to engineers in all branches, but to chemists as well.

Then, again, conferences should be held from time to time between teachers and practical engineers and chemists for the exchange of ideas on the subject of the schemes of work and study to be followed by the student-apprentice, so as to turn out all-round men and not unpractical theorists or unscientific practists.

We have to improve in many ways our college teaching, so as to expend to better advantage the available time and place more stress on ability to use information than to store it.

One result of the war and of the economic pressure which will follow will no doubt be to diminish the time given to amusements and games at both schools and colleges. There will be a more intensive interest in intellectual matters. The inclusion of military training as part of school education will create a more disciplined type of schoolboy and more zealous college student—and we shall be able to advance matters a stage, so that things now taught to first-year students at college will be learnt at school, and things which were only learnt after leaving college will be taught there in a third year.

Engineering and chemical students should be brought much earlier than at present into contact with questions of cost and estimates, so that they may know not only how and why a certain machine works, but what it costs to make it or to run it. They will then be far better able to take advantage of the workshop training and obtain earlier that "workshop sense" or instinct which looks at everything from the point of view of cost and profit, as well as operation or efficiency.

We have before us a tremendous task to restore the waste of this great war. To do this we have to utilise all waste products and to abolish waste and inefficiency in all departments of life, domestic, commercial, political and industrial, and we have to get rid of them in scientific work as well.

We can only do this by bringing to bear the scientific method upon all these regions of activity and even upon scientific research itself. As a small contribution to this work the above suggestions are tentatively put forward, and with the greatest diffidence I submit them now to your careful consideration.

DISCUSSION.

MR. JAMES SWINBURNE, F.R.S., in opening the discussion, said the first thing a traveller ought to settle when setting out on a journey was where he wanted to get to. In the present instance, there were two or three objects in view: first, the recovery of England and the Allies economically; secondly, the further suppression of Germany, which was a different proposition altogether, and which might be exclusive of the first, *i.e.*, this country might be itself in considerable difficulty in trying to hurt Germany economically after the war; and, thirdly, whether they desired to secure the independence of the nation, *i.e.*, to manufacture everything in the nation for economic reasons or with a view to providing for another war. If science had been neglected in England, in his opinion the science of economics, which was by far the most important for the nation and for the public, had been neglected more than any other. Some men did not mind exporting cotton to Germany, because they said that if the export of cotton was stopped the Germans would make gun-cotton out of wool; they also said it was no good stopping lard and oils going into Germany, because that country now had command of Galicia and could get all the oil it wanted from there. Such people could probably easily be persuaded that their chemistry was very groggy indeed, and after argument would admit that they were talking nonsense; but when men expressed the latest lunacy on economics that they had obtained from political papers

no power on earth would persuade them that they were talking nonsense. Most people seemed to assume that economics was not a science, and that the mere casual reading of a halfpenny paper would put them in a position to discuss the most complicated problems. A confusion also arose in the discussion of the subject dealt with in the paper between what was good for us as a nation and what was good for mankind. Scientific work generally was good for mankind, but research did not necessarily do the nation any good unless the information gained was kept exclusively for the nation. If a discovery was published in the journals of this nation, and another nation, which was a good copyist, made use of it, he did not see how it helped this country, nationally, at all. He had some compunction in saying anything that sounded like criticism of the author, because he (Mr. Swinburne) realised that Dr. Fleming was one of the most practical of our scientific men; it was not generally realised that this country owed the National Physical Laboratory to him. But in his opinion there was a general confusion between scientific research, industrial research, and invention—three things which were absolutely different. Men who carried out scientific research were not considering the commercial importance of the different elements, but simply desired to complete a huge organised structure of knowledge. But the man who carried out industrial research was not concerned with that question at all. He did not want to know anything in particular except how to improve something so that he could develop his particular industry. Invention was a different subject altogether, involving a different type of man. The scientific man who made researches was not the least likely to be an inventor, although he might be on occasion. The author of the paper was a good example of that. There was a general tendency in this country to say that our industries were not scientific. That he believed was a calumny. He knew something of the industries of the country, and he thought they were about as scientific as they could be. It was always said that England had a kind of national diffidence, and that it was the only country that ran itself down. He believed Mark Twain said that England was mentioned in the Bible, because the statement was made: "Blessed are the meek for they shall inherit the earth." But that national diffidence might not really be diffidence; it might be individualism as contrasted with collectivism. The vanity of a country which prided itself on its so-called patriotism took the form of saying that everything in that country was perfectly good. This country, on the other hand, was individualistic and did not do that. Each member of the community said: "I am very good, but the rest of the country is awfully rotten." But the curious thing was that the people who said that the country was rotten in various ways were not really the people concerned. For instance, many people said that the present war was being conducted in a perfectly fatuous way, and it was only necessary to read the papers to find articles by novelists and clergymen showing how the war ought actually to be run. He did not wish to compare the author either with a novelist or with a clergyman; but he wished to emphasize the point that the accusations of want of science which were made against British industries were not made by scientific people who were engaged in industry, or who had anything to do with it; they were made by the scientific people whose business it was to educate students, *i.e.*, by the professors of the various universities. He did not want to be disrespectful to such people at all, but he did not think they knew much more about industry than the novelist and the clergyman knew about the war. He also wished to point out that research as research could not be national; it could only be for the good of the world at large, because it was practically impossible to keep it peculiar to the country. He heartily agreed with the author that any kind of research in the hands of the Government was quite useless. To begin with, a committee of any kind was utterly useless. Many present had spent much of their lives on scientific and other kinds of committees, and knew how bad they were; but those who had ever been on Government committees knew how infinitely worse they were. It was possible for a man who was on a committee to do something in spite of being on that committee, but he could only do it as a strong man, struggling against difficulties, outside the committee. He thought the suggestion made by the author in regard to research students was not likely to be very practical. Pure research work, while useful, was very dull and uninteresting, and he did not think many students were likely to undertake it. It might succeed by mixing up scientific research with industrial research, but that type of student was the least likely of all to invent anything. Personally, what he thought was required was, firstly, that students should be trained in economics at school as one of the fundamental things that everybody ought to know something about; secondly, that the State should never be allowed to lay its deadening hand on any industrial advance; thirdly, that students should be trained at college not in technology so much as in principles, obtaining as much scientific training as possible from people who were able to impart such knowledge, and then do their research work in the works afterwards. That might take a little longer time, but it would certainly produce better results. He did not know whether it was possible for the college laboratories to be placed at the service of industrial concerns. He understood that the function of a university was to teach students, and the author's suggestion would commercialise the universities by using them for other purposes. Universities were at present largely used for pure research work, which was very interesting for the professors but did not necessarily teach students, and if they were going to be used for industrial

research work he thought the training of the students, which was the first thing the universities were supposed to do, would go to the wall. Finally, he suggested that the Patent Laws should be entirely remodelled, not by a number of politicians, patent agents, and patent lawyers—although each of those classes would have to be consulted—but chiefly by people who industrially used patents and by inventors.

SIR WILLIAM A. TILDEN, F.R.S., said that many of the propositions laid down in the paper required a great deal of further consideration before he could safely pronounce a definite opinion upon them. This country suffered to a large extent from the curious national indifference to what had been called "things of the mind." The British were not an intellectual people; they had been occupied too much in the past in other ways; but they had now received a horrible shaking up and were beginning to turn over a new leaf, which it was hoped would lead to a reform in the future. But the reform must begin at the top, and for that purpose it was necessary to see that the composition of the House of Commons was altogether changed. At the moment he could think of only one accomplished and eminent man of science who occupied a seat in that body, and it always seemed to him that the time of Sir Joseph Larmor was entirely wasted by sitting in that assembly. Half the Members of the House of Commons ought to be as well educated in subjects of physical science as the other half were educated in the old classical manner, so that the absurd mistakes that were made, both in speech and in action, by Ministers who were responsible for the conduct of the affairs of the country should not occur. But more than that was required, namely, a reform in all the offices in Whitehall. He remembered ten or eleven years ago Mr. Haldane, in an after-dinner speech, said that when his party got into power a substantial proportion of scientists would be put into every office in Whitehall; but when his party did get into power he (Sir William) did not see much change in the composition of the higher members of the staff, and they seemed to preserve the same attitude towards scientific questions. Some new offices also needed creating, particularly one which should be in closer touch with the applications of science to industrial affairs than was the Board of Trade at the present time. Personally, he deprecated any steps being taken which might lead to a diversion from their proper employment of men who were capable of making discoveries. If scientific people were grouped together, one group being able to investigate one subject and another another, no doubt a considerable commercial success would be met with, because that was the sort of system which prevailed in the German chemical works. Personally, he wished to look at the question of research from a broader point of view. If the history of physical science was gone into, it would be found that all the really great advances in fundamental principles had been made by the English and the French. Faraday, at the end of his days, had only an income of £300 a year in addition to a house at Hampton Court lent him by the Queen, but he was quite happy with what he had. So he believed was the really inspired discoverer, who did not undertake his work with a view to making a fortune, but with that kind of divine curiosity which led him to look closely into the features of Nature. It was that which had inspired British people in the past, and which had achieved such satisfactory results; so that, although he believed the councils of the learned societies would willingly lend themselves to assist in the process of organisation, he could not help feeling some sympathy with Mr. Swinburne's query as to what would come of it. The council of the Chemical Society could meet and discuss and formulate a good many useful rules, but he was not quite sure how much would come out of it. This country had suffered in the past from the intrusion of the non-expert into the expert field. One important question, deserving of the closest consideration, was how the young men who appeared to be properly qualified to undertake research were to receive the sort of experience they required to make them understand industrial problems. He was not quite sure how far the scheme of sandwiching, to which the author had referred, would be possible in connection with chemistry, although he believed it had worked satisfactorily in connection with engineering. He felt that the Germans had settled that question for this country on a practical scale. In Germany university graduates, who had been thoroughly instructed in the principles of various subjects, were taken into the works under contract for a certain number of years; they were paid a salary which was sufficient for them to live upon modestly and they had a prospect before them. It was that prospect which entered so largely into the vision of the young man. In this country it was very difficult to know how far to encourage a clever young fellow, at the end of his graduation, to go on with scientific work, because he immediately said: "What will it lead to?" If he were offered a scholarship or fellowship for two or three years, unless a scheme could be arranged by which the fellowship was of a progressively increasing value as time went on, so that there was a sort of profession for him to look forward to, he did not think the best of the men would compete for such a fellowship. He hoped the eminent heads of industrial concerns would take rather more interest in the matter than they had shown up to the present. On occasions such as this he would like to see one or two big manufacturers present, who would state in plain language what their views were as to the possibility of turning to more practical account the scientific resources of the country.

Dr. H. S. Hele-Shaw, F.R.S., said he was deeply interested in the question of the student and the relation of the professor to the student. He was not a professor at the present moment, as he had been actively engaged in the pursuit of the engineering profession for the past ten years, but the best part of his life he had spent as a professor, so that he was able to look at both sides. Owing to the enormous development of technical colleges and local universities, the professor in this country was at the present time more largely engaged in promoting research than any other individual, but there were three things with which he was confronted: firstly, with the choice of the subject, because the student almost always appealed to him; secondly, with the advice he had to give as to the method in which the research was to be carried out; and thirdly, and most important of all, with encouraging the student to continue the dreary work of research. Personally, he did not believe in results which were quickly attained. There was such a thing as luck, and some men seemed immediately to hit on an idea which made them famous, although such instances were very rare. The major portion of research work was of a dry, dull and plodding nature. At the present moment research was hopelessly mixed up with invention, but those who had worked at both knew the difference. The paper gave a very clear idea of the difference between invention and research, and from that point alone would do much good. Many works did not feel justified in expending money, because they thought that the man who carried out the research would go away from the works having made some great discovery at their expense. He also desired to emphasize the importance of encouraging students to tabulate, not necessarily for publication to the world at large, all the work they had done which did not lead to any result. Much of that work was good work, and it ought to be possible to institute a committee of scientific men to encourage and reward the student for all the labour he had expended on it.

Dr. W. H. Eccles thought that many scientific men would agree that there was a possibility of the organisation of industrial research, but many of them would argue that there were some things which could not be organised. For instance, no one would propose to organise the fine arts. It was impossible to imagine a gathering of a great number of painters with the object of painting a fine picture. In the same way, it was impossible to get collaboration in literary work over any long period. In the higher reaches of science also, where inspiration and individual genius were the principal factors, one ought not to attempt to organise. Though such a scheme as the author had brought forward might be very appropriate for industrial research, it might be very harmful in purely scientific research. Those two complicating sides of the question had to be borne in mind in any discussion of the subject.

Professor William A. Bone, F.R.S., said that personally he was very apprehensive of research work, whether purely scientific or industrial, getting into the hands of committees. There were some questions on which a committee might be a help in guiding the research, but primarily research was carried out by independent people. He had had a good deal of experience of working with, and conducting researches for, committees, and he very rarely experienced the sensation of receiving ideas from those committees as to how the work was to be done. The work was usually left to the individual members. He saw a great danger in what he called specious schemes of scientific Socialism. He was a strong believer in the individualistic principle. If the people of this country desired to choke the progress of scientific discovery and invention, then such matters should be placed under the heels of committees.

Professor Henry E. Armstrong, F.R.S., said the general impression he obtained from the author's views did not appeal to him, and he would be more inclined to follow the views of Mr. Swinburne. Dr. Fleming had complained of the ignorance of politicians and of the public. Personally, he did not think the author had the slightest right to make those complaints, because they themselves were the authors of that ignorance in a large measure. Twelve or fourteen members were nominated by the Royal Society as fit and proper persons to serve on the governing bodies of various important schools, but they never met together; they were not associated in any way in that work; they were not asked to exercise any influence, and they received no instructions of any kind whatsoever. Sir William Huggins, who was very much interested in the problem, had brought the matter forcibly under the notice of the Society on several occasions, and a meeting of the public schools representatives was once held, but it came to nothing. So long as they were not organised amongst themselves, and had no policy which they could force upon the schools, they had no right to complain of the ignorance of the public and the politicians who came from those schools. He did not believe any improvement would be seen in Parliament after the war for one, two, or three generations. For the past thirty or forty years they had been to a certain extent slaying certain prejudices. The rising generation would start with a few of those prejudices gone, but with its own prejudices coming along probably. Unless the scheme of British education was absolutely reformed, he did not believe this country would make any progress. He quite agreed with the author in taking exception to the appointment of the new Advisory Council for Research. Dr. Fleming said that scientists ought

to do the work; and so they ought. They ought to have taken the work in hand long ago, but they had done nothing. An appeal had been made to the Royal Society over and over again to organise science as a whole, but the Royal Society would not listen to it, and until the Fellows of the Royal Society in the first instance were effectively organised as a whole, he thought no progress whatever would be made, not because he believed organisation would effect much, but because by organisation a new spirit would be brought into being. When the individualism of this country was organised the nation would be irresistible, but he did not believe they were going to do it. If it had not been done in the past one and a half years it would not be done in the next one and a half years, and they would forget all about it when the war was over. There were two kinds of research, the free-lance research and the directed research of industry with a definite object. The less the free-lance research was touched the better. What had been done in that respect in modern times had not been at all salutary; there had been too many committees at work and too much asking what subjects should be dealt with. As a teacher, he had always felt that what was wanted was that money should be available that he could be trusted with, and when he had a man who was competent to do work he should be put in a position to remunerate that man without being asked a lot of questions of what likelihood there was of something resulting from the work. If research could be helped in that kind of way, things would go ahead, but if it was necessary to appeal to advisory committees and Royal Society committees they would not get very far. The Germans had shown this country how to do directed research work, and, in his opinion, if we were not prepared to copy them we should do no good. Industrial work must be done under industrial conditions, for the most part in the works; and it was only when large problems which were common to the whole industry were dealt with in that way that good resulted. The real school for the training of men for industry in Germany was the works laboratory. The men were trained academically in the first place; then they went into the industry and got their chance. He believed there was a good deal of senseless talk about German methods at the present day. It was necessary to be philosophic in regard to such matters, and adopt the Japanese method of picking out what was good and applying the knowledge acquired in that way. He thought we had it within our power, out of our own knowledge, to do most of what was required, if boys were turned out from the schools prepared to receive ideas. He was not a believer in the statement that the English were not an intellectual people; he believed our disease was an acquired one brought on by the teaching in the schools, the only solution of which was to crucify or in some other manner get rid of most of the headmasters.

MR. WALTER F. REID, in supporting the last speaker's remarks, said that most young fellows in this country were taught more to play than to work; they left school with great ideas on games but with no scientific knowledge. He desired to emphasize the point that inventors were treated very badly indeed in this country. A chemist who went into an industrial works received a very small salary, and he was not encouraged by the firm to use his intelligence or his inventive genius in such a way that it would be of benefit to him: it was always a question of benefiting the firm that engaged him. The employers insisted on most iniquitous agreements being signed, prohibiting the chemist from benefiting in any way from any invention he might make when in the service of the firm. He knew, as Chairman of the Institute of Inventors, that nearly every month they were asked to advise on agreements of that kind. The matter required urgent attention, but he was afraid that, as Parliament was constituted at present, nothing would be done. More hopeful to him than anything else was the meeting recently called by the Lord Mayor, when seventy mayors from the chief cities of the country met at the Guildhall, and when the Lord Provost of Glasgow referred especially to what he called "all talk and no work." He thought if the heads of large towns and industries joined together they would be in a position to bring about the substitution of practical men for unpractical politicians. Since the war commenced a very great injustice had been done to many inventors. A number of industries were practically stopped, but those who had patents connected with them had to keep up their payments on them, because the Board of Trade refused to allow the patentees to postpone the payment of their fees until after the war. That was most grossly unfair: the Government would not help the inventor in the slightest degree. At a time when many people were searching for information with regard to the manufacture of new products that were urgently required, the Patent Office library was closed at four o'clock, although as a result of representations it was agreed that on one day of the week it should be kept open until six. That was very injurious to the country, and unless some society, such as the Royal Society of Arts, used its whole influence to alter such practices, the best use would not be made of inventions. The inventor ought to be encouraged, and not discouraged as he was at present.

MR. J. W. LOVIBOND, speaking as a scientific free-lance of forty years' standing, said he had limited himself to one particular line of investigation, namely, the analysis of light and colour sensations, but he did not wish the young people he had under his charge to be limited in that way—he wished them to have opportunities of a wider scope of education. On turning, however, to the handbooks dealing with the subject, he found that, although the refraction and reflection of light were

fully dealt with, colour was almost ignored. He found also that several conflicting theories were being taught by the different educational authorities, and that there was no common language or notation. That condition of things pressed very hardly upon the men who were defending us abroad at the present time. He held the view that aeroplanes could be rendered less discernible by scientific colouration, but he found there was a general impression amongst scientific men that it was so difficult that it was hardly worth while giving it a trial. On the other hand, he had sufficient evidence to show that a practical advance had been made in the subject.

Mr. L. Gaster desired to emphasize the point that if any Government Department was approached with a definite object in view, the matter was taken up in a practical way. Speaking from experience, he knew that the Home Office had taken up the question of illumination and lighting, which at one time was entirely neglected, and had now issued a most admirable report on the subject, which was a guide to those interested in the question not only in this country but in the rest of the world.

The Chairman (Dugald Clerk, D.Sc., F.R.S.), in proposing a hearty vote of thanks to the reader of the paper for his excellent contribution, said that he agreed with him to a certain extent, and he fully agreed with Mr. Swinburne in regard to the necessity of studying economics. There was no doubt that scientific men were weakest on the subject of economics and business, the business man being better informed on those subjects than the average scientific man. At the same time, he thought scientific men were at the present moment greatly overrating the danger of foreign competition. Sir George Paish, in a very admirable address he recently gave at the London School of Economics on the economic strength of Great Britain, said: "The British nation has never made the mistake of being too clever. The greatest qualities possessed by the British nation are common-sense and courage, combined with lack of imagination. Their foresight is confined to doing the next thing that presents itself. Each difficulty as it arises is dealt with either wisely or unwisely. Their great wealth has been built up by their inability to realise the meaning of the word 'danger,' either from a physical or from a financial standpoint. The British people are prepared to take greater risks than any other people in the world, and this quality has brought to them an income and a degree of well-being that can scarcely be measured." In 1903 the united income of the British people was about £1,700,000,000 per annum, and it had risen in the year 1914 to £2,400,000,000 per annum. The efforts of British business men were more successful than those of any other nation except America, and they resulted in greatly increasing the wealth of the country, so that the average income per head was £53 per annum. Competition with another nation was not a thing to be afraid of, and the prosperity of another nation was not a thing to be afraid of either. Some people, even scientists, seemed to think that all the nations of the world were sellers and not buyers. It did not follow that because a man was a discoverer of a new gas he knew anything about economics. People spoke as if all the nations were busy exporting goods to other places somewhere, not to other nations, but to some shelf outside the world, were cutting each other's throats to send the goods there, and were getting nothing back in return, or, if anything did come back to this country, it was "dumping." Even people of ordinary intelligence were horrified at the excess of imports into Britain over exports. That very fact was a measure of Britain's success, because the measure of success of any nation was the excess of imports over exports. A nation wanted to get back as much as it could for what it put out; but some foolish people would make this country receive only a very small amount of imports back. While he agreed with the author as to the necessity for looking into all the different matters with which he had dealt, personally he had no fear of competition from Germany or any other nation. Britain was thoroughly well able to give a good account of herself, because she was well prepared both in science and in industry. Scientific men often did a great injustice to themselves. He was glad to hear Sir William Tilden say that England and France were the principal scientific nations of the world, so far as discoveries were concerned. They were, and they were also the principal industrial nations of the world, England especially. He had no doubt that England would continue to be so, and the £4,000,000,000 which England had invested in foreign countries would be the greatest lever in her favour in the respect that she would always have both exports and imports. It was quite a misleading analogy to use the expression "war on industry." There was no war on industry. This country wanted everything that other people could give, and the other people wanted everything we could send them, and if any nation fancied they could send things to other nations without receiving goods back, the sooner they went to school and learned economics the better. The author desired him to say, in conclusion, that he would reply in writing to the various remarks that had been made.

The resolution of thanks was then put and carried unanimously, and the meeting terminated.

Sir Robert A. Hadfield, F.R.S., writes:—"Although fearfully rushed with war work, added to by the recent air raid, I have found a short time to glance through your paper, with most of the conclusions in which I am in hearty

agreement. I am confident you are on the right track in objecting to the formation and organisation of research by a Government Board. In order to obtain the best results we want to get away as much as possible from past grooves, which have not been particularly successful. I could a tale unfold of what I have of late seen in this respect, and am sure such an arrangement would not be in the best interests of the country. We certainly want, so it seems to me, not to be under academic or bureaucratic influences. As you rightly point out, there are excellent means for dealing with the matter already in existence in the shape of our magnificent technical societies and institutions, which are able to diffuse knowledge in a manner I believe not equalled by any other country, except perhaps America, which, being Anglo-Saxon, runs on our lines. If money is to be spent, why not place it in their hands to do freely as they think best? I am confident that more value would be obtained for the money expended. At any rate, let us give the plan a trial before running to bureaucracy and red-tape methods. I have, too, been very much impressed with a recent letter to the *Telegraph*, in which the writer, in the name of 'Efficiency,' advocates the foundation of a Ministry of Science. I believe with a Minister of Science and a Minister of Commerce this country would benefit enormously. Science is not merely high and dry knowledge, but is just as much subject as business itself to advance and progress by duly prepared and organised methods. The valuable work by the late Dr. G. E. Gore, F.R.S., 'The Art of Scientific Discovery,' a book not half sufficiently known, and which I have constantly quoted, shows this in an unmistakably clear manner. It deserves reprinting and placing in the hands of our educational authorities for distribution amongst those concerned. If you would find £100, I would give the same sum to pay for copies of Gore's book to be circulated far and wide in the proper towns. Dr. Gore's writings and suggestions have always had a great influence on me, and I think the book should be in the hands of everyone who is now studying how and in what way the progress of science is to be helped on. I hope this idea of a Minister of Science, for the first time I believe promulgated in the *Telegraph*, will be taken up in earnest; it is a splendid suggestion. Why not make the President of the Royal Society, Sir J. J. Thomson, the first Minister? As a Fellow of this Society I have for a long time seen and watched his work, which is of the highest, whether in thoroughness or originality. The attempt now made to obtain scientific progress by means of the Minister for Education is, I think, a mistake. The present occupant of that post is my friend, the Right Hon. Arthur Henderson, a man made for the times and nobly doing his duty for the Empire. He, and also previous occupants, would be the last to claim that they could adequately deal with the problems of 'science' as apart from education. No; we want a man for the post who will devote himself specially to the suggestion made by 'Efficiency.' This nation would greatly benefit if it were carried to a practical issue. Science and education are not at all the same: in other words, plenty of men are highly educated and yet they may not be scientific. How, therefore, can the wants of the scientific man be met through the ordinary educational channels? The co-ordination and organisation afforded by a Ministry of Science would be, so it seems to me, of the greatest possible value to this country. I trust, therefore, that this suggestion will be pursued and eventually carried into effect. Again let me say that the opinions expressed by you, with your great experience of both the highly scientific and technical sides, are invaluable. It is with the greatest regret that I shall not be able to be present at the meeting. It seems to me that your scheme is admirable, but it wants a head, and that head should be, for example, to quote what I hope may represent the future policy of this country, a Minister for Science, the first of whom, as I have suggested, might well and properly be Sir J. J. Thomson. Make him our first Minister, and with the aid of his many colleagues in the Royal Society, and other scientific and technical societies, there would be a marvellous development and increase in appreciation of science itself and in the application of science to industrial uses, upon which you rightly lay such important stress. I am also very glad to see the well-deserved compliment you pay to the Duncan scheme in connection with the Mellon Institute and the University of Pittsburg. In this, too, I feel confident there are germs of important development to the application of science to industrial purposes."

Dr. J. A. Harker, F.R.S., writes:—"I hope that the author's suggestions will be carefully considered. I was specially struck with two points mentioned: firstly, the need for more organisation in the compilation of the programmes of our learned societies with a view to the stimulation of increased interest in their proceedings, and in particular of the meetings themselves. In absence of information whether an author would be present to communicate his paper, one often felt hesitation as to whether it was worth while attending a meeting where perhaps the only paper on the programme of definite interest might easily be taken as read. Speaking as a Member of Council of the Faraday Society, I am sure that the method of organising occasionally a discussion on a definite subject, on which written contributions by specialists were invited, is one which had thoroughly justified itself in practice. On the evening of the discussion authors were only expected to touch briefly on salient points, since all the papers had been previously printed and circulated and speakers came prepared with their contributions. As Professor Fleming pointed out, this method of procedure, though rare, is not unknown at the Royal Society. Everyone who was present will

remember the discussion on the internal architecture of the atom opened by Sir Ernest Rutherford. Such occasions justify a long journey in order to be present and furnish to workers incalculable stimulus and inspiration. The second point was the need for better machinery for placing available information, the results of recent research, at the disposal of those needing it. I have been much impressed lately by this, and I could give many instances. A week ago a Government Department rang up the National Physical Laboratory on the telephone regarding an important war problem for the solution of which the Department proposed to institute immediate experiments at their laboratories. The writer found that though the data required had probably never been tabulated in the desired form, yet a short search and a few minutes' arithmetic enabled an answer to be sent back at once, thus obviating needless expenditure of time and money on experiments."

MR. RICHARD B. PILCHER, Registrar and Secretary of the Institute of Chemistry, writes:—"Had time allowed, I should have been glad to contribute to the discussion on Professor Fleming's paper, and to thank him for his reference to the work of the Institute of Chemistry. Whether it be described as the pursuit of invention, or as research, the results obtained by the Glass Research Committee of the Institute are, to my mind, an object-lesson, the main point of which is that success in scientific investigation depends on the selection of the right men for the work. At the outbreak of war, the stocks of laboratory glassware, hitherto entirely supplied from abroad, were speedily exhausted. The Germans had produced this glassware for over forty years, had made a speciality of it, and had all the necessary material for its manufacture in their own country. The Institute received an appeal signed by the directors of twelve of the largest steel firms in the country to take up the question of ensuring the supply of beakers and flasks; the Home Office asked for a formula for miners' lamp-glasses, and the Army medical contractors were known to be in urgent need of glass suitable for X-ray tubes. Within a few months the committee were able, through the work of Professor Herbert Jackson and Mr. Thomas R. Merton, of King's College, London, to provide formulas for meeting all these requirements. These results could not have been obtained without continuous research, mainly of an academic character, carried out by Professor Jackson with the object of arriving at the principles, chemical and physical, underlying the conditions for producing the glasses. Only the urgency of actual production has up till now delayed the publication of these researches. Mention should also be made of the intricate analytical work carried out by Mr. Gilbert J. Alderton, under the supervision of Mr. Bertram Blount. In arriving at the formulas, it was necessary to find substitutes for certain constituents, of which supplies were becoming practically exhausted; yet the glass is fully equal to the best German laboratory glass, and in some respects superior. Moulds had to be made and other devices to be obtained to enable manufacturers to produce all ordinary forms of glass apparatus. Even accurately graduated vessels with stopcocks of various forms will shortly be produced in large quantity by the British manufacturers, with whom the Glass Research Committee have been in touch throughout the work. The prices at which the ordinary forms of apparatus can be produced compare favourably with pre-war German prices, and there is every prospect that the industry will be held in this country after the war. It is certain that the manufacturers will make a good stand. Those to whom I refer, moreover, are not only good business men, but men with modern scientific training, and who appreciate science. All users of such ware should be urged to support these British manufacturers, for the industry is one in which we must be independent. It is not only important to remember that the chemist has now established his indispensability, but the instruments of his profession must be readily obtainable. The expenses of the work of the Glass Research Committee up to the point I have indicated were borne partly by the Institute and partly by Professor Jackson himself. Altogether twenty-one distinct formulas for glass required for scientific purposes are now available. The work is steadily progressing with the aid of a grant from the Committee of the Privy Council on Scientific and Industrial Research, from whom also a further grant has been allotted for research directed to the provision of certain forms of optical glass. I would venture to repeat that the Institute had the advantage of knowing where to find the right men for the work, and I think that in all practical problems directly affecting industry the aim should be to secure the right men, whether they are attached to a college or institution, or in consulting practice. Work of such pressing necessity should be entrusted at all costs to men of experience who have accumulated knowledge, and can at once bring it to bear on the subject to be investigated. In this work, moreover, a definite line of procedure was agreed upon from the start by the committee, under the chairmanship of the late Professor Meldola, and intimate touch was maintained with the manufacturers during and after the investigation up to the point of successful production. In other industries of direct concern to the practice of chemistry—porcelain laboratory ware, filter paper, reagents, etc.—British chemists have enabled British manufacturers to overcome all difficulties and to produce the necessary supplies. The Institute has been the means whereby many chemists have taken a part in industrial work, and I know that the British manufacturers have learned more and more to appreciate the value of placing well-trained and competent chemists in positions of control, not only in laboratories but on

the works. I believe the British nation can find chemists as fully able as any German chemist to solve any problem in industry. Moreover, I submit that whatever may be the failings of our public schools, they have succeeded in maintaining the British standard of individuality which has proved our greatest asset in peace and war, and particularly in times of stress. With all our facilities for training chemists and with their increasing influence in industry, I cannot share the gloomy outlook with which we are so often threatened."

MR. WALTER F. REID writes:—"In the discussion on Professor Fleming's suggestive paper, one fact was specially referred to, namely, the want of recognition, by the politicians who are at present in authority over us, of those who have done good work in science and industry, and especially of the inventor. The present state of war shows us how absolutely dependent we are upon new inventions if we are to maintain our place in the forefront of civilised nations, in war as in peace. And yet those who invent and produce the appliances and materials which will ultimately enable right to prevail over might are not thought worthy of any recognition, while honours are showered upon combatants for deeds which the inventor has made possible, and which, in fact, have a very slight influence upon our chances of success. The want of recognition of scientific men by the State is little less than a public scandal, and it is not to be wondered at if the best brains in the country are not attracted into channels that appear so limited. At the present moment the safety of Great Britain depends largely upon the work of the chemist, without whose loyal co-operation we could scarcely hope to cope with a nation which holds chemists in high esteem. And yet our Government even goes out of its way to prevent English chemists receiving any notice at all. Some years ago the French Chemical Society celebrated their fifty years' jubilee, and the chemical societies of this country sent three well-known chemists to convey their greetings to their French colleagues. The French Government, with a courtesy that our own might envy, offered the Cross of the Legion of Honour to these delegates of one of our most important branches of science and industry. Our own Foreign Office would not allow our countrymen to accept the compliment, and thereby gave our French friends to understand either that we did not value the proffered gift or that those to whom it was offered were not worthy of receiving it. Not long afterwards a military gentleman took a letter to a foreign Court and was given a high decoration—for a service which our Post Office could have carried out more expeditiously for 2½*d*. Some time before war was declared it became apparent to scientific men in this country that our army and navy were in a dangerous state of dependency upon Germany for the supply of optical glass, which is so necessary for the waging of modern warfare. The Royal Society, in conjunction with the National Physical Laboratory, appointed a competent committee of chemists to study the subject and introduce the industry into this country. Manufacturers were found willing to help; but a small, a very small, sum was required for the cost of the preliminary work, and this was refused by the Government. Everyone knows that at the outbreak of war it was necessary to do in a hurry what the Government had been urged to do long before. It is quite useless to discuss details of research and kindred subjects until we have executive officials who themselves possess sufficient elementary knowledge of science to be able to appreciate its importance in every branch of modern civilised life. The administration of the Patent Laws shows how little our State esteems the services of inventors; they are looked upon mainly as a source of income, whereas the real interests of the country would best be served by a cordial recognition of all those who have inventive genius. If an inventor does not patent his invention he has not the slightest chance of recognition in this country. For instance, the inventor of the process by which all the powder used in the present war is made is an Englishman, yet the only public recognition he has received has come from France and—Germany. Until we get rid of incompetence in high places, and give the scientific and technical worker the status which is his due, we shall not occupy the position among the nations which might be ours."

A VISIT TO THE WESTERN BATTLE FRONT.*

Permission was given to proceed to Ypres, which we did in the motors by way of Vlamertynghe, and the cars were deposited in the shelter of a wall at the canal head of the Yser Canal.

We then proceeded on foot to the headquarters, located in the middle of the town, where we were furnished with a guide to show us round Ypres itself.

Of the Cloth Hall one pinnacle alone remains standing, and we were told that the Germans not only have a daily shot at this pinnacle, but at least once a week shell the place freely. Not that there is anything in the shape of a building worth shelling, everything from the cathedral down to the smallest pork-butcher's shop being absolutely riddled with shell and shot, but apparently the object of the enemy's intermittent fire is to catch, if possible, the many troops who from time to time pass through the town to and from the trenches.

As a matter of fact, I saw the German "good-night" shell explode, as it seemed to me, right in the middle of Ypres, the result being a cloud of dust, and nothing more.

* Extracted from an account by one of a party of seven civilians who were invited by the War Office to visit the Western Front.

Having seen all that there was to be seen of the town, which was simply desolation of desolations, we proceeded on foot eastward, with the object, unexpected in the morning, of getting actually into the trenches. On leaving the town we came to a point where two roads parted, one south-east to Menin, the other east by north to Zonnebeke.

We walked in single file, being assured that a party like ours walking *en masse* would be spotted to a certainty, and after a most deviating journey, through the town cemetery to begin with (where tombstones flat and shell holes numerous made locomotion none too easy), we got for a few yards on to the road, then off again into the fields. Here we were halted to see if any airplane was having a look at us, then back to the road, walking probably for a hundred yards or so up the ditch, and so on until we came to another headquarters at Potyze, where we were within 1,500 yards of the first line of German trenches.

Thanks to an officer at these headquarters I was provided with a pair of thigh gum boots, being told that the ordinary knee boots would make progression in the trenches quite impossible. We were each of us also provided with anti-gas helmets, which, however, were not likely to be required, as the wind was unfavourable for the enemy. Then we proceeded, again in single file, to the second line of the British trenches, which are named after fashionable West End streets, and in the official war maps they are so described. For example, we entered by a communication trench called Haymarket, which led up to other trenches named Piccadilly, Jermyn Street, Duke Street, and so forth.

This particular position had been shelled freely by the enemy from 3 p.m. till dark on the previous day, and not only were the effects of the German fire plainly visible (barbed wire entanglements blown to smithereens, etc.), but the appalling state of the weather—rain in torrents throughout the day we were there—had turned the trenches into a stream of sliding mud.

We got as far as mud would allow, and were then within 1,100 yards of the German first line.

From where we were we saw what was described in the British Headquarters despatch on the following day as follows :—

" We bombarded the German position east of Ypres."

In these laconic words the official despatch describes a marvellous artillery duel between the German guns, which were behind a place called Railway Wood, about 4,000 yards away, rather to our right as we faced the German lines, and the British guns, which were, God knows where, somewhere miles behind.

We could see the German " Jack Johnsons " belching forth for all they were worth, and could hear them too, very plainly, even at that distance.

We could not hear the firing of the British guns, but we saw their shells burst, sending up mud spouts, which seemed to be hundreds of feet in height. We were told when we got back to headquarters that the British guns had done particularly good work that day.

The order then was to clear out of the trenches as quickly as possible, and we lost sight of one of the most amazing artillery conflicts which one could possibly imagine, though we continued to hear the roar of the big guns until we got right back to Ypres and long afterwards. We returned from Potyze by another road and by a very tortuous route back to the canal head at Ypres.

ZACATON GRASS FOR PAPER STOCK.

Attention is called to the possibilities of zacaton grass in the manufacture of paper in a new professional paper of the United States Department of Agriculture, Bulletin No. 309. Zacaton grass extends from California and Texas southward to the Argentine Andes. It grows most profusely, however, in the mountain regions east and west of the City of Mexico, where it is harvested for the sake of its roots. These are made into brushes of various sorts, and for this reason the zacaton plant is frequently known by the common English names of broomroot grass, wire grass, and rice-root grass. At the present time the tops of the plants are allowed to go to waste. It is from these that there is reason to believe that a satisfactory paper-making material may be developed.

An acre of grass should yield at least three tons of tops. The plant is a perennial one, the growth being almost entirely from self-sown seed. Unless checked by fire, cultivation, or the harvesting of the roots, the grass will soon cover a field solidly, and it is not uncommon to find many square miles densely covered with the growth. The range can be profitably gone over for roots every third year.

Laboratory tests of this grass conducted by the United States Department of Agriculture show that it can be chemically reduced to paper stock by the soda process more easily and with less expense than is necessary to reduce poplar wood. The same processes and methods which are employed for the manufacture of pulp from poplar wood are quite suitable for the treatment of zacaton, but in place of the wood-sawing, chipping, and screening machinery a grass duster is necessary.

The paper manufactured from the stock has proved as satisfactory in physical tests as a first-grade, machine-finished printing paper. It has,

moreover, a very satisfactory appearance and feeling. For bleaching, however, the experiments showed that more bleaching powder was required than with poplar stock.

The percentage of air-dry fibre obtained from the zacaton grass appears to be somewhat less than that from poplar wood, but practically equal to that of esparto. Forty-three per cent. of air-dry fibre was obtained in the Government experiments from air-dried grass, while the fibre yield from poplar wood ranges from 46 to 48 per cent.

No estimate of the cost of manufacture is made in the Bulletin mentioned above. A rapid increase, however, in the demand for paper, and the increasing likelihood that the raw material that is necessary for its manufacture will not be sufficient to meet this demand, make the subject worthy of further investigation by the trade. It has been estimated that the growth of wood in the United States is being removed at the rate of 36 cubic feet per acre each year, while the natural increase is at the rate of 12 cubic feet per acre. In other words, wood is being used three times as fast as it grows. The consequence is, of course, a continual increase in the price of raw material, and the desirability of finding some substitute is obvious.

BRAZILIAN PIASSAVA.

Among the forest resources of Brazil one of considerable value and importance is the fibre piassava, a product of certain palm trees, which is used in the manufacture of brooms, brushes, ropes, baskets and hats. The trees also produce a very hard nut, called in Portuguese "coquilho" (coquilla), from which excellent buttons are manufactured. The leaves are employed in making fans and, in the country districts, for roofing adobe houses. For making brooms and brushes, especially, no other material is more extensively employed in Brazil, and large quantities are required annually for domestic consumption as well as for exportation to Europe. The quantity and value of the exports of the fibre from Brazil in 1912 were as follows:—

To	Metric Tons.	£
United Kingdom	1,007·8	29,000
Germany	336·6	9,700
Portugal	196·3	5,700
Argentina	26·2	800
France	8·4	220
Belgium	6·2	170
	1,581·5	45,590

All but 12·3 tons was shipped from the port of Bahia. Some small shipments have been made lately to the United States. In 1914 only 55 lb. were sent, but in the first five months of the current year 12·6 tons, valued at £500, or between 4½*d.* and 5*d.* per lb. f.o.b. Bahia, have gone thither. It is said that the United States does not buy more because of competition from a variety of the same fibre grown in Africa.

Piassava is gathered from two species of palms, scientifically classified as *Attalea funifera* (mart) and *Leopoldinia piassaba* (wall). The Leopoldinia yields fibre in greater abundance, but its stand, so far as is known, is much more limited than that of the Attalea. Of the two varieties, the piassava of the Leopoldinia palm is the more delicate as to strength and finer in texture, but harder and very resilient, which accounts for its more common use in the manufacture of clothes-brushes, horse-brushes, to some extent flesh-brushes, and for cords and ropes, especially for nautical purposes, where strength, combined with small size and marked resistance to the action of sea water, is desired. This variety is most abundant in the Amazon region, in the tributary valleys of the Negro and Padouiry Rivers; but it is also plentiful in Northern Bahia, where, however, it is confined to the River Preto and other small feeders of the São Francisco. Though not gathered in quantities like the Bahian piassava (the common name for the Attalea variety), the last-named location is the region of its most extensive exploitation.

The Attalea palm is plentiful over large areas in the southern part of the State of Bahia, and exists in Northern Espirito Santo, and to some extent in Upper Bahia and Alagoas.

According to a report by the United States Consul at Bahia, piassava is gathered when ripe by drawing the fibres out from folds wound spirally around the tree at the base of the leaves, which seem to grow as a protection to the palm. It is extracted by unwinding and drawing out, the bunches obtained measuring 8 ft. to 15 ft. in length. The palms are exceedingly prolific in their fibre production, as from both varieties piassava can be gathered twice annually, a single tree yielding 4 lb. to 7 lb. at each drawing. The yield can be increased 30 to 40 per cent. by cutting down the tree and stripping it of all fibre, and, unfortunately, this wasteful method is so common that, unless legislative action is soon taken, the extinction of the piassava palms in the central forest zone is merely a matter of time.

After gathering, the fibre is allowed to dry for a time under cover, when the fibres are drawn singly from the tangled bunches and assorted as to length and grade. The dark-coloured fibres (of a dark brown shade) are the more valuable, as are the thicker and longer strands. The thick fibres are used for brooms and rough brushes, and the long ones for ropes and cords. The product is prepared for market in sheaves weighing 90 lb. to 110 lb., and sells in Bahia for 300 reis to 500 reis per kilog., or approximately 2*d.* to 3*d.* per lb.

ARTS AND CRAFTS.

War Memorials.—The inauguration of the Civic Arts Association and the meeting in its support at the Mansion House have produced a good deal of talk, and some correspondence in the public press, on the subject of war memorials. We are told, and very rightly told, that when the war is over we are to have a care that our memorials are better than the erections which perpetuate (not always pleasantly) the memory of Queen Victoria's Jubilee. We are also informed, again with considerable truth, that private memorials could and should be much better than they are. Various suggestions are, of course, offered as to how this state of affairs has arisen and is to be remedied. It is said, on the one hand, that the great sinner is the artist, who will carry out what he wants to do, not what the public (who, since they know that they do not like the atrocities of earlier times, presumably know both what they like and also what is good) really ask of him. Again, it is urged that the trouble arises because, owing to our undue submissiveness to the artist (exactly how this comes about is not made clear), a race of tradesmen has sprung up who foist upon the general public what they do not want. It is insisted that what we need is simpler work carried out by good craftsmen. No one denies that there is some truth in all these statements, especially perhaps the last two; but to get to the root of the matter we have to consider the iniquities not only of artists, architects and the like, but of the general public. It has yet to be proved that, say, the mayor and other civic officers of a small Midland town, or of one of the less enlightened London boroughs, would do better if they prepared a scheme for a memorial and gave it to a local craftsman to carry out than they would by entrusting the whole thing to an artist of some standing. It is at any rate doubtful whether the craftsman himself would think so at the end of the proceedings. There have been instances, of course, where a wayward artist has insisted on doing the wrong thing, but as a rule the work has suffered (more, perhaps, when entrusted to an artist than to a tradesman) from the fact that the designer has not been given a free hand, and the memorial when finished is the result of a compromise between him and his clients which is satisfactory to neither party. The trouble, as a whole, has been the dual control which has almost inevitably led to bad results. Whether the control should be in the hands of the artist or of the public is a question which might be answered in different ways. To reply adequately would demand some knowledge of the particular artist and the particular public involved. To substitute craftsman for artist may or may not help to get over the difficulty. Some of the best craftsmen are quite as determined to have their own way as any more ambitious artist. At the Mansion House meeting a way out of the *impasse*, by the formation of an association ready to give advice to both parties, was suggested. This sounds attractive enough, but the public has to have some guarantee of the capacity of the proposed association before they are likely to trust it to any very great extent. The meeting in the City was well attended. The speakers included Mr. George Clausen, R.A., Professor Selwyn Image and Professor Lethaby, whilst Mr. John Lavery, A.R.A., Mr. Frank Dicksee, R.A., and Sir C. Harcourt Smith were present. In other words, both painting and professorship were quite well represented; but with the exception of stained glass, the arts most commonly needed in connection with war memorials—sculpture, architecture, decorative painting, mosaic work—do not seem to have been seriously considered. This is the more to be regretted, as it is artists and craftsmen connected with these branches of art who have the greatest experience of the practical difficulties connected with the erection of memorials of all kinds. Any society which hopes to do good work in connection with memorials will have to be strong in men who are acknowledged masters, not of art theory or of painting alone, but of the arts, crafts and materials most directly concerned.

Further, while it may be hoped that some wise national control may be exercised over the erection of public monuments, the ordinary Englishman likes to settle (or at any rate to think he settles) his own private memorials for himself. What he wants is not so much artistic direction over particular points as a deeper artistic sense (which the proposed closing of the national collections will hardly assist him to acquire) and some elementary knowledge of the technical difficulties. In how many memorial tablets, for instance, is the lettering cramped and the proportion of the whole spoiled because the donor has had the happy inspiration at the last moment of adding to the length of the inscription, and it has been impossible to convince him that the change would make any real difference? He pays for so many extra letters, he argues, and it is the artist's business to make them fit in as best he can. It never crosses his mind, when he does not like the result, that the fault may be largely his own.

Wallpapers.—The wallpaper trade, like all industries which are largely dependent on colours, has suffered through the war. It will probably suffer still more from the restrictions on the importation of wood pulp. Meanwhile, since people must have something on their walls, business to some extent goes on. Moreover, a fair number of new designs are appearing this year, most of them drawn or commissioned before the war, but still new to the public. We did not import much in the way of wallpapers from Germany, though some of the plain

papers bought from Holland may have had a German origin. On the other hand, a good many French papers were sent to this country, and we exported to a considerable extent to the Continent and America. This last market is still open to us, and its existence should be a reason for seeing that the trade is not allowed to languish too badly. We want to export to America now, as well as to keep our market open for the future. Contrary to what might have been expected, this year's papers, though sometimes on a black ground, are generally bright and fresh in colour, and though purples are well to the fore, there is no lack of gay tints of all kinds. The increase in the use of transparent colours may be due to motives of economy; but it has tended to improve rather than to injure the effect of the patterns produced by this method. Stripes, once so popular, seem to have suffered at any rate a temporary eclipse, and spots are somewhat less in evidence, whilst their place has been taken by small all-over patterns which, without pretending to be anything great in the way of design, do, when they are properly planned, give a very pleasing effect. Some ingenious panelling arrangements with corners and side pieces, carefully schemed. are still being produced. It is worth noting that in nearly all the more highly priced papers there is still some suggestion of texture other than paper. This varies from a slight roughness, not intended to simulate anything in particular, to a deliberate imitation of silk or some other fabric. There is nothing remarkable in the continued production of the cheaper kinds of goods, but it is much more surprising that even at the present time a number of block-printed papers are being brought out. These have a much longer lease of life than the machine-printed papers, and are not necessarily, even in war time, an extravagance. Messrs. Jeffery & Co., whose work of this type is so well known, have never allowed their machine work to overwhelm this side of their production, and again this year they are bringing out quite important patterns, some on the lines of old silks and printed fabrics, some more modern in type, and yet others Japanese in feeling. There has been plenty of talk about carrying-on during the war, some of it sensible, some rather futile; but if we are to be ready for trade expansion when the present crisis is over we must have kept the best of our designers going while it lasts. If we are to do that, those interested in art, who can by any means afford it, should see to it that when they have to buy either wallpapers or fabrics they get new as well as good designs.

The Design and Industries Association.—The Design and Industries Association held its first annual meeting towards the end of last month. The society has now a membership of over two hundred, including a number of well-known artists and craftworkers, and a very fair proportion of members interested in manufacture and distribution; it has held one quite successful exhibition, and is beginning to make itself felt. If its ideal of drawing together artists and producers is not quite so new as some of its promoters seem to imagine, it is at least one which in recent years, owing very largely to the influence of the artist-craftsmen, has been allowed to drop out of sight. It is a good sign that this most important question is being considered seriously and with good will by a group of younger artists connected with various branches of applied art. Co-operation of this kind ought to have a good effect, not only on our design and manufacture directly, but also on the knowledge and taste of those who sell commodities into which the question of art enters in any considerable degree, and on the training given in our trade schools. If artists and manufacturers were really working together the trade schools, already doing excellent work, should become the training ground of workers capable of assisting by their knowledge and intelligence the movement towards unity.

OBITUARY.

Frederick Louis Myers.—Information has been received of the death of Mr. Frederick Louis Myers, of Kingston, Jamaica, which took place while he was on a visit to New York on October 5th last.

Mr. Myers was born at Kingston sixty-three years ago. On completing his education he decided to enter on a business career, and he started as a wholesale merchant and commission agent in his native city. Under his management the firm prospered, and finally became one of the largest and most powerful business organisations, not only in Jamaica, but in the British West Indies, and owned a large part of the wharfage of Kingston.

In addition to his business interests, Mr. Myers was a director of the *Gleaner*, a Kingston newspaper, and a member of the committee of the Kingston Chamber of Commerce. He was recently appointed Chief Magistrate of Kingston. He was also one of the trustees of the Royal Jamaica Yacht Club, in the affairs of which he took a great interest. He was a generous supporter of many charitable institutions, and the Jamaica War Contingent Fund owed not a little to him.

Mr. Myers only became a Fellow of the Royal Society of Arts last year.

GENERAL NOTES.

Banks and the War.—Mr. Walter Leaf, deputy chairman, when presiding at the annual ordinary general meeting of the London County and Westminster Bank, said that one of the

most satisfactory features about the great War Loan in July last was the manner in which their customers provided the money themselves; the cases in which the bank was asked to assist in subscriptions by loans were quite trifling in comparison, and there was no doubt that the amount subscribed represented the actual savings of the country, not any artificial inflation of credit. The immediate effect of that loan was, of course, a considerable drop in their deposits, which had no doubt been abnormally increased in anticipation of it. But that drop had since been largely made up again, and they had the satisfaction of seeing their aggregate deposits nearly eight millions in excess of those which the bank showed a year ago—a far larger sum than had ever appeared on any of their annual statements. The balance-sheet showed the large scale on which their bank, in common with all the banks of the United Kingdom, subscribed to that loan. All of the shareholders had now the opportunity of subscribing to the needs of the war in another form, that of the 5 per cent. Exchequer Bonds, which were now "on tap." He would urge upon all the desirability of doing so to the very utmost of their power. Sir Edward H. Holden, Bt., presiding at the general meeting of the shareholders of the London City and Midland Bank, Ltd., said that Germany, by the Law of August 4th, 1914, released the Reichsbank from its obligation to pay its notes in gold, and further authorised the creation of all kinds of notes without any gold cover at all. Traffic in gold was restricted by a penal Statute, passed by the Bundesrat on November 23rd, 1914, the effect of which was to make the buying or selling of gold coin at a premium punishable by fine or imprisonment. As their gold was tied up, German traders could only pay for imports by exports and securities, or by borrowing, or if there was an excess of imports and sufficient additional securities were not forthcoming, the exchanges must fall. It was quite certain, judging from the excessive fall of the German mark, that the imports into Germany from the Scandinavian countries, and from Holland, were largely in excess of her export of commodities and securities to those countries. Although the German mark had fallen about 33 per cent. in Holland, and about 23 per cent. in Scandinavia, they must not be premature in drawing conclusions. While it might betoken an exhaustion of German securities, yet the situation might be rectified to some extent if the gold were permitted to be exported. Of the two evils a fall in the exchange, or a loss of gold, the German Finance Minister preferred the former, and kept his gold. He had some good reason for keeping the gold, and it might be that when peace was restored he would begin to import commodities as quickly as possible, and as he would not be able to pay for such imports either with a depreciated currency or with sufficient exports, he would pay with his gold and try to restore the exchanges until such time as he could prepare his imported commodities for export.

Timber for Sleepers.—Particulars are contained in the recently published report of the Imperial Forest Research Institute, Dehra Dun, of experiments in connection with various timbers for use as railway sleepers. Four hundred and sixty sleepers of *terminalia tomentosa* were treated with mixed oil by the open tank process and laid down on the Great Indian Peninsula Railway, while the behaviour of sleepers previously laid down of *terminalia tomentosa, pinus longifolia, pinus excelsa, dipterocarpus, tuberculatus*, and *alatus* was carefully watched. Various sleepers have been laid down during the last few years, those treated by the Powell process have been in the track the longest. All are reported free from white ant attack. The *dipterocarps* and pines show signs of rail cut, indicating the need of bearing plates, while the latter showed signs of cracking and splitting, especially *pinus longifolia*. Mr. Pearson, the economist, has spent a portion of his leave in England in studying the various pressure and seasoning processes and their cost. Experimental work as regards oil absorption was taken up in Assam in connection with the indigenous woods with varying results. Gurjan sleepers were sent to England for treatment under the full cell process with good results, while 8 B. G. sleepers of ten promising timbers are being tested in England by the Ruping process. The whole subject of sleeper treatment is full of interest, but must still be regarded as being in the experimental stage, so much depending on the mechanical life of the various timbers. Minor investigations were carried out in connection with the physical, mechanical and seasoning properties of various timbers, while endeavours have been made to find markets for certain species. Investigations were also made, as far as time permitted, into a large number of products, such as tannins, gums, resins, oleo resins (the Boswellia gum promises to yield important results), fibres (especially that of *helicteres isora*), oil, seeds, essential oils, timbers suitable for paving blocks, pencils, casks, bobbins (for which there is a large demand) and lance shafts, etc.

Encouragement of Olive Cultivation in Tripoli.—To encourage the cultivation of the olive tree in Tripoli, a decree has lately been issued by the governor-general of that colony, offering a premium of 40 centimes for each plant raised from seed or cutting. A free distribution of cuttings of the olive tree will be made by the "*Ufficio agrario*" at Tripoli to intending growers and colonists. The young plants must be healthy and well grown.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m. :—

February 16. — S. Charles Phillips, M.S.C.I., "Paper Supplies as affected by the War." Lord Burnham will preside.

February 23.—Miss H. B. Hanson, M.D., B.S., D.P.H., "Serbia as seen by a Red Cross Worker."

March 1.—Charles Delchevalerie, "Belgian Literature."

March 8.—Charles R. Darling, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

March 15.—Edward Percy Stebbing, F.L.S., F.R.G.S., Head of the Department of Forestry, University of Edinburgh, "Forestry and the War."

March 22.—Rev. P. H. Ditchfield, "The England of Shakespeare."

Victor Horta, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

Professor T. G. Masaryk, "The Slavonic Peoples."

G. P. Baker, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

Arthur S. Jennings, "Painting by Dipping, Spraying, and other Mechanical Means."

Indian Section.

February 17.—C. A. Kincaid, C.V.O., Indian Civil Service (author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.), "The Saints of Pandharpur: the Dawn of the Maratha Power." Lieut.-Colonel Sir David W. K. Barr, K.C.S.I., will preside.

March 16.—Professor Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

April 27.—James MacKenna, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

May 18. — Sardar Daljit Singh, C.S.I., "The Sikhs."

Colonial Section.

February 28 (Monday, at 4.30 p.m.).—Percy Hurd, "Next Steps in Empire Partnership."

April 11 (Tuesday, at 4.30 p.m.).—Sir Daniel Morris, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

May 2 (Tuesday, at 4.30 p.m.).

Dates to be hereafter announced :—

R. W. Seton-Watson, D.Litt., "The Balkan Problem."

W. A. Craigie, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

Cantor Lectures.

Monday afternoons, at 4.30 p.m. :—

J. Erskine-Murray, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

Fothergill Lectures.

Monday afternoons, at 4.30 p.m. :—

Rev. Dr. Herbert West, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "National and Historic Buildings in the War Zone: their Beauty and their Ruin." Three Lectures.

Syllabus.

Lecture II.—February 14.—*Gothic Architecture, French and English.* The French Cathedral, a Great Hall, the centre of the city's life. The English Cathedral a Monastic Missionary settlement, independent of the city. The problem of Mediæval Architecture, to reproduce Roman vaulting—Solved by permanent stone centrings (diagonal ribs) under the intersections of a groined vault (Vezelay, Durham, St. Denis, Sens). Buttresses necessary (Chartres, Amiens, Beauvais). The walls become screens of glass. Inside—Columns replaced by vaulting ribs running down to the ground (Notre Dame—N. D. de l'Épine, Abbeville). Contrast of French and English plans (Notre Dame and Salisbury). In the English Cathedral, horizontal, not vertical perspective sought. Beauty of clustered columns. Purbeck causes deep mouldings. Multiplication of vaulting ribs. Lierne and fan vaulting—Flamboyant and perpendicular—English and French façades—The French Cathedral is the expression of the National ideal; the English, of the National history.

Lecture III.—February 21.—*French Mediæval Sculpture.* Christian art that of a new-born society rising amidst a dying civilisation—Provençal sculpture, Arles, etc., decadent—Burgundian, full of life and imagination; but Classical

influence traceable all through (Vezelay, Autun, Auxerre)—XIIth Century (Avallon, Bourges, N. and S. doors, Chartres, W. front). Elongation of statues, architectural not ignorant—Individual types, elaborate detail. The sculpture scheme of a XIIIth Century cathedral (Laon, Notre Dame, Amiens, Reims). The Judgment door (Autun, Notre Dame, Amiens, Rampillon, Reims, St. Maclou)—The Virgin's door—Local Saints and legends (St. John Baptist, Rouen; St. Stephen, St. Théophile, Paris; St. Thomas, Semur; St. Nicaise, Reims)—The Arts, Virtues and Vices—The Months and Daily Life (Paris, Amiens, Rouen)—Statuary (St. Stephen, Sens—The Virgin, Paris—Chartres, N. and S. porches)—Reims, W. portals—Figures of Christ (Chartres, Amiens, Reims, Troyes, Solesmes).

The lectures will be illustrated by lantern-slides.

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 14...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Fothergill Lecture.) Rev. G. H. West, "National and Historic Buildings in the War Zone: their Beauty and their Ruin." (Lecture II.)

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Hon. W. P. Reeves, "The Balkan States." (Lecture II.)

Cold Storage and Ice Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m.

Brewing, Institute of (London Section), Imperial Hotel, Russell-square, W.C., 8 p.m. Mr. H. C. Sweatman, "The Work in a Brewery Cooperage."

TUESDAY, FEBRUARY 15...Sociological Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.15 p.m. Mrs. St. Clair Stobart, "The Meaning of War from a Woman's Standpoint."

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. H. Manfield, "Oil Shales, especially those of Dorsetshire."

Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m. Major L. Darwin, "Statistical Enquiries needed after the War in connection with Eugenics."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "Nerve Tone and Posture." (Lecture V.)

Philosophical Institution, Edinburgh, 8 p.m. Mr. O. Bainbridge, "Turkey and the Turks."

Hampstead Antiquarian and Historical Society, Central Library, Finchley-road, N.W., 8.15 p.m. 1. Annual Meeting. 2. Address by the President (Dr. H. B. Wheatley), "Pepys' Work at the Navy Office and the Admiralty."

WEDNESDAY, FEBRUARY 16...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. S. C. Phillips, "Paper Supplies as affected by the War."

Meteorological Society, 70, Victoria-street, S.W., 7.30 p.m. 1. Mr. C. E. P. Brooks, "On the Rainfall of Nigeria and the Gold Coast." 2. Dr. J. R. Sutton, "South African Coast Temperatures."

University of London, King's College, Strand, W.C., 5.15 p.m. Mr. S. Low, "The War and the Problems of Empire." (Lecture III.)

Microscopical Society, 20, Hanover-square, W., 8 p.m. 1. Messrs. Heron-Allen, Earland and Rousselet, "The Progress and Development of Vision and Definition under the Microscope." 2. Mr. J. E. Barnard, "An Experiment with the Ultra-Microscope."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor Gerothwohl, "The Octopus of German Culture."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.30 p.m. Mr. C. F. Marsh, "Reinforced Concrete as applied to Waterworks Construction."

THURSDAY, FEBRUARY 17...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. C. A. Kincaid, "The Saints of Pandharpur: the Dawn of the Maratha Power."

African Society, Hotel Cecil, Strand, W.C., 8 p.m. Major J. J. O'Sullevan, "The Campaign on the German East Africa-Rhodesian Border."

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Chemical Society, Burlington House, W., 8.30 p.m. 1. Mr. P. W. Robertson, "The simultaneous estimation of carbon and bromine by the chromic acid method." 2. Messrs. J. B. Cohen, D. Woodroffe, and L. Anderson, "The relation of position isomerism to optical activity. Part X.—The menthyl alkyl esters of 3- and 4-nitrophthalic acid, etc." 3. Mr. E. E. Turner, "A new reaction of semicarbazide hydrochloride." 4. Mr. A. G. Perkin, "Note on a product of natural indigo manufacture." 5. Mr. L. Aitchison, "The action of sulphuric acid upon alloy steels." 6. Mr. S. G. Sastry, "Additive compounds of s. trinitrobenzene with heterocyclic compounds containing nitrogen in the ring." 7. Mr. A. Bramley, (*a*) "The study of binary mixtures. Part II.—Densities and viscosities of mixtures containing substituted phenols; (*b*) Part III.—Freezing-point curves; (*c*) Part IV.—Heats of reaction and specific heats."

Royal Institution, Albemarle-street, W., 3 p.m. Sir Frank Dyson, "Measurement of the Brightness of Stars. Lecture II.—The Variable Stars."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. C. M. Thomas, "A Printing Process for Physical Development."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. (Kelvin Lecture.) Dr. C. Chree, "Terrestrial Magnetism."

Historical Society, 7, South-square, Gray's Inn, W.C., 5 p.m. Anniversary Meeting.

Numismatic Society, 22, Albemarle-street, W., 6 p.m. Mr. J. Mavrogordato, "The Coins of Chios. Part II.—478-334 B.C."

Geographical Society, Kensington-gore, W., 5 p.m. Dr. J. F. Unstead, "A Synthetic Method of Determining Geographical Regions."

FRIDAY, FEBRUARY 18...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor E. G. Coker, "Polarised Light and its applications to Engineering."

Economics and Political Science, London School of, 5 p.m. Hon. B. R. Wise, "Industrial Organisation."

University of London, Bedford College, York Gate, Regent's Park, N.W., 5 p.m. Professor J. S. Mackenzie, "The Relation of Right and Might."

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, Westminster, S.W., 6 p.m. Mr. H. Fowler, "Chisels."

SATURDAY, FEBRUARY 19...Royal Institution, Albemarle-street, W., 3 p.m. Hon. J. W. Fortescue, "Eminent Generals of the last Great War. Lecture I.—Sir Ralph Abercromby and Sir Charles Stuart."

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FRIDAY, FEBRUARY 18, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 21st, 4.30 p.m. (Fothergill Lecture.) REV. DR. HERBERT WEST, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "National and Historic Buildings in the War Zone: their Beauty and their Ruin." (Lecture III.)

WEDNESDAY, FEBRUARY 23rd, 4.30 p.m. (Ordinary Meeting.) MISS H. B. HANSON, M.D., B.S., D.P.H., "Serbia as seen by a Red Cross Worker." SIR FRANCIS CHARLES GORE, K.C.B., Hon. Treasurer of the Serbian Relief Fund, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

FOTHERGILL LECTURE.

On Monday afternoon, February 14th, the REV. DR. HERBERT WEST, D.D., A.R.I.B.A., delivered the second lecture of his course on "National and Historic Buildings in the War Zone: their Beauty and their Ruin."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

TENTH ORDINARY MEETING.

Wednesday, February 16th, 1916; THE RIGHT HON. LORD BURNHAM in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Barneson, Captain John, 310, Sansome-street, San Francisco, California, U.S.A.

Parrish, Samuel L., Southampton, Long Island, New York, U.S.A.

Sadd, W. A., Chattanooga Savings Bank, Chattanooga, Tennessee, U.S.A.

Tabor, Joseph Matthew, Peninsular House, Monument-street, E.C.

The paper read was—

PAPER SUPPLIES AS AFFECTED BY THE WAR.

By S. CHARLES PHILLIPS, M.S.C.I.

INTRODUCTION.

I would like, with your permission, at the outset to say that this is a subject it is impossible to approach without a sense of difficulty, because it is outside the range of possibility at the moment to form even an approximate idea how the war may affect paper supplies, and in considering the material for this brief paper I have been compelled to realise how almost from day to day the situation alters and the element of uncertainty in regard to paper supplies, and incidentally, I may add, paper prices, are affected. I assume it is the wish of the Society, or at least I interpret their wish as a desire, that I shall present a few facts which concern particularly the British Empire. In saying this it must be borne in mind that the general interests of the paper trade, and of the raw materials upon which the paper trade depends, are international in extent, and it is desirable in considering how Great Britain and Ireland may be affected to glance briefly at what is happening in various parts of the world where we buy and sell paper. The importance and influence of this indispensable commodity are so great that in this twentieth century the world would without it, so to speak, come to a standstill. It is already a matter of history that this country was embroiled in the present terrific war through what Germany termed a "scrap of paper."

Two outstanding facts force themselves firstly upon our consideration, viz., that when war broke out in August, 1914, the considerable supplies we were receiving from Germany and Austria were cut off, and, of course, have not since been resumed. I do not propose at this stage to mention in detail the particular classes of paper in which Germany or Austria

admittedly specialise, but they exercised a great influence in our markets, and are very well known in the paper trade. It will be realised from the figures I am about to present that the mere fact of these supplies being stopped by force of circumstances affected paper consumers in this country at once, and the effect has been more acute as the war has progressed. Outside the countries with whom we are actually at war quite a number of other paper-producing nations have been directly affected. France, Belgium, and Italy, being deeply involved in the struggle, have been and are unable to supply this and other countries with the particular classes of paper to which they had devoted their attention with considerable success. Although the supplies from our Allies referred to have not been entirely cut off, they have been greatly hampered; in fact, within a recent period France has been in our market as an important buyer, particularly for "news" or, in other words, the class of paper used for the printing of newspapers.

The countries directly affected by the war are Great Britain, Ireland, Germany, Austria, France, Belgium, Italy, Russia (Finland), Japan, and, incidentally, America and Canada, as the extraordinary increase in freights, chemicals, coal, and other indispensable commodities has made the effect, generally speaking, world-wide. And, of course, Norway, Sweden, and Holland, with whom we do an enormous business, have also found that the effects of the war are of considerable importance in many directions. Finland, too, on whom this country depended largely for nature browns and a fair quantity of "news" and boards, has been almost cut out of our market, and only those directly associated with the paper trade can realise how the stoppage of these supplies and the general chaos resulting from the war has affected and will affect consumers and traders.

Many people are wise after the event, and some of the comments on what has happened in the paper trade have been made rather lightly and apparently without full consideration. In my opinion, the general conditions governing the situation could not possibly have been accurately predicted or the effects gauged when war broke out. The conditions so far as they concern the paper trade and many other trades were, of course, unprecedented, and it is not surprising that some of our best-informed business men formed erroneous ideas as to what would probably happen. In this consideration it is well to bear in mind the factors directly governing paper prices. First we will deal with the supplies of raw materials—wood pulps, esparto, rags, coal, chemicals, dyes, etc., and it must be borne in mind in this consideration that substantially all wood pulps are imported into this country. This applies also to esparto, and everyone, no doubt, is fully aware how largely we were dependent on Germany for the dyes necessary for the production of coloured papers.

Probably we may at no distant date learn something regarding the involved and embarrassing situations arising and likely to occur with regard to the interpretation of pre-war contracts and contracts made since the war broke out. Some of these involve great difficulties and hardships, but so far as I can learn the general inclination of traders in Great Britain appears to be to interpret their obligations in a reasonable spirit, although, in saying this, I am well aware that some interested people will not agree with me.

If time permitted I could deal at length with the unforeseen difficulties, not only in regard to the production of paper, but also in carrying out certain contracts, and in regard particularly to deliveries, and those intimately associated with the paper trade are pretty well aware how these difficulties and the recent methods of conditional quotations affect merchants, agents, and buyers. Probably when the war is over we shall realise the great and noble part our British Fleet has played in enabling wood pulp, esparto, etc., and paper to come to our shores so freely since the so-called blockade of this country was announced. Literally, although there have been some misfortunes and a number of ships have been sunk, there has been no insuperable difficulty in regard to the landing in Great Britain and Ireland of cargoes from Scandinavia or from Canada and America. In this matter our misguided neighbours across the North Sea—the Germans — have, I must admit, acted impartially, for they have sunk more neutral ships, Norwegian, Swedish, and Danish, carrying such cargoes than British ships—a kind of impartiality which has not been appreciated by the neutrals referred to. It is true that freights have made shipping virtually impossible from certain ports, but the dreaded blockade, as such, has not materialised; and I think you will agree with me when I say it will not do so. I propose to give you a few figures, and these will serve to correct certain erroneous ideas which, I believe, are widespread.

It will be noted that America comes first in importance as a paper-producing nation,

although the bulk of the paper produced in the United States is consumed at home. It has been stated more than once that Germany, as regards bulk, took a strong lead. This you will note is not the case, although Germany and Austria had come along at a great rate as exporters. It remains to be seen how these figures will be altered by the war and after the war. America, it will be observed, has not played a great part in relieving the situation here, and this has probably been due in the first instance to a want of knowledge of our requirements and the conditions under which business is done over here; also, of course, to the high freights which make the shipment of cheap grades of papers by European buyers very difficult — though with the high prices prevailing to-day the question of freight should not form a serious obstacle. The same remark applies to some extent to Canada, and personally I hold a very strong view as to the part Canada will play at no distant date in regard to the production of both pulp and paper; but it may be well to bear in mind that the United States of America is, geographically, the natural market for Canada, although in normal times Canada can ship to Great Britain at a cheaper rate than the material costs for transport to some of the important centres in the United States. While on this subject, I might state that during my many visits to Canada for the past thirty years, I have endeavoured to implant enthusiasm and interest among my pulp-making friends over there in the direction of developing their mills on a larger scale with the view of competing over here for a much larger portion of our pulp business which is awaiting them. In spite of the war, the Canadian wood-pulp business is being developed in a very gratifying manner, and after the war it will receive a much greater impetus. We cannot afford to put all our eggs into one basket.

Buyers were quite in the dark as to what might happen when war broke out, and panic prices and a rush to place orders practically at doubled figures, particularly for "news" and printing papers, occurred immediately war was declared. Then a reaction took place and an indifferent demand, coupled with over-production, resulted in very poor prices. Naturally the fact that most of our paper-makers were well covered for pulp requirements had much to do with this phase of the subject. As a matter of fact, contracts for paper could be placed at pre-war prices. The market experienced a period of great uncertainty, some mills working on very good contracts, some on very poor contracts, some mills being actually short of orders for a period, whilst further dislocation was caused by certain mills, usually turning out higher classes of paper, having accepted contracts for newspaper publishers' requirements.

It is well known that some of our most astute buyers made serious mistakes in regard to the market. Some contracts were cancelled for considerations, and one of our largest firms paid a substantial cheque to a paper firm to secure the cancellation of one big order.

I could say much if it were necessary as to why prices have increased, are increasing, and may probably continue to increase, and those who understand the position will realise that paper-mill managers in this country cannot reasonably be expected to commit themselves to contracts for long periods ahead.

It is gratifying to know, as I do know, that the British Paper Makers' Association is fully alive to the possibilities now opened to the British paper trade by securing a large amount of business hitherto in the hands of foreign firms, and this applies not only to the paper consumed here, but also to the export trade. It is also fairly well known that many paper-mills in Great Britain are now spiritedly making, with considerable success, classes of paper which have hitherto for some reason been classified as foreign papers. These include greaseproofs, flints, fancy box linings, imitation greaseproofs, krafts, gold and silver foils, very thin papers for special purposes, vegetable parchment, etc.

I have been frequently asked what may be the position of the British paper trade after the war. On this subject I am an optimist, and I believe that the war has had the effect of consolidating our paper-makers, removing to a large extent the mutual suspicions which seem to be part of the paper-makers' natural constitution, and also bringing the principals into closer touch, with very excellent results.

I am also well aware that in the last decade the great improvement in paper-making methods and equipment, also in technical and commercial education, have placed British paper-making firms in the front rank, considered from the international standpoint; and incidentally it is also gratifying to know, as a matter of fact, that in regard to paper-making machinery it is now fully recognised that our British engineers are in a better position to-day, providing they are not occupied on munitions, or other Government work, and labour is available, than ever before.

No doubt our paper-makers will take a leaf out of the Germans' book, throw over the old rule-of-thumb system and adopt more scientific methods in an industry which is acknowledged to be more susceptible of scientific treatment than most other industries of this country.

Had British paper-makers been more alert and less conservative in their ideas and actions years ago they would not have allowed the Germans to have monopolised many lines of paper and thus made us dependent on them for supplies. As in the case of other British industries, we have only to thank our insular ideas and proverbial prejudices for neglecting to foster business in our mills and factories which the Germans have exploited so profitably.

Paper Production of the World.

The most recent estimate of the paper and board production of the world which I have been able to turn to is that of Mr. G. R. Snellman, of Helsingfors, a well-known authority, who in 1912 gave it as 7,856,591 tons of paper and 1,576,289 tons of boards, which gives in round figures a total of about 9½ millions of tons. These figures, no doubt, are now considerably below the mark, but they will afford a fairly reliable basis for estimating the proportion of paper products of each of the belligerent countries. In passing, it may be interesting to observe that up to the outbreak of war about 37 per cent. of the paper manufactured throughout the world was produced in the United States of America, which are also to be credited with the production of about 60 per cent. of all the boards manufactured. Dealing with the belligerent countries, it appears that in respect of paper the percentages* of production are as follows: Germany, 17·1; England, 11·1; France, 7·6; Austria-Hungary, 4·4; Canada, 3·2; Italy, 2·9; Russia, 2·8; and Finland, 1·2. With regard to the manufacture of boards, Germany's production on the census I give is equivalent to 11·8 per cent.; that of France to 5·8; Canada, 3·2; Austria-Hungary, 2·2; Russia, 1·5; and England, 1 per cent. The fact that we are not a pulp-producing country accounts for the low percentage of boards produced by our mills.

Conditions in the British paper trade at the outbreak of war were of normal though moderate prosperity, one of the most significant features being the huge development in the output of news and printing papers in the Thames district. This had been planned on the most modern and enterprising lines for securing economical production, with the result that it is doubtful whether there is any place in the world able to turn out these two classes of paper at such a low cost. I have the authority of a well-known paper-maker in Lancashire for stating that new southern mills come nearer to a solution of the foreign importation problem than anything ever before attempted in Great Britain. I shall have something to say shortly with regard to our imports of paper and boards, but here it is convenient to remark that about one-half of our total consumption of paper is of foreign origin, and though that consumption has continued to increase, the growth has been very largely met and monopolised by German and Scandinavian manufacturers. Home products of paper normally average between 700,000 and 800,000 tons, while the total annual imports of paper during the last three years amounted, in 1913 to 394,080 tons; in 1914 to 359,000 tons; and in 1915 to 322,000 tons.

These imports consist of almost every kind of paper except finest writings, and in this connection it may be said that Germany and Austria sent us some papers of great artistic merit, evincing the highest skill in manufacture, in addition to papers of peculiar utility which are quite specialities. Among these may be mentioned filter papers, photographic papers, fancy greaseproofs, vegetable parchments, leather papers, ferro-prussiate papers, telegraphic tape papers, etc., most of which are expensive products, and mostly the result of patient and highly-skilled labour and enterprise.

Naturally the war has, to all intents and purposes, put an end to our import of these specialities, the absence of which has been keenly felt. It is therefore gratifying to be able to state that great efforts are being made, and will, no doubt, continue to be made, to produce them in our British mills. My own opinion is, and it is endorsed by more than one British paper manufacturer, that there is a reasonable prospect of success under the stimulus of very high prices resulting from scarcity, and that there seems every reason to believe that the encouragement of the efforts which are being made in this direction may ultimately render us independent of the foreign supplies. In that event British paper-makers will have achieved a fine conquest over an entirely new field, in which up to now German supremacy has been practically unchallenged. With this object in view I would plead for a sympathetic attitude amongst buyers towards our paper manufacturers in the early

* These, and other percentages, are approximate only.

stages of what is a new, and may become a very important, development.

In view of the fact that so large a proportion of our supplies of paper comes from enemy countries and countries at present under their control, it is not surprising that we in this country have experienced a gradually increasing scarcity in our markets. This arises not only from the stoppage of supplies from Germany and Austria, but, to a large extent, from the diversion of Scandinavian paper products to the South American and Far Eastern markets to replace papers previously supplied by Germany. As a result, for many sorts of paper something approaching famine conditions exist, and it will in my view undoubtedly become necessary to make some organised effort to check the immense waste of paper which goes on daily. There is no doubt that very great economies in the use of paper are possible, and to remedy this state of things Government, municipal, and other public bodies, as well as industrial and commercial concerns and private individuals, can do much by the exercise of rigid economy in the use of paper of all kinds.

Imports of Paper.

The main sources from which this country in pre-war times supplemented its own production of printing and writing papers of various kinds were Sweden, Norway, Newfoundland, Germany, Belgium, Finland, and the United States, France also contributing a small quantity. Packing and wrapping paper, especially sulphite papers, was chiefly derived from Sweden and Norway, of which countries Germany was a close competitor, while Belgium and Russia, with "other countries," sent us appreciable quantities. Imports of "news" paper were principally from Norway, Newfoundland, and Sweden, in the order indicated. These furnished between them in 1913 about 85 per cent. of our purchases of this class of paper, which totalled 131,443 tons. Germany's contribution was only 8,640 tons, or slightly over 1·3 per cent. Of printing and writing paper not on reels we imported in 1913, 50,109 tons, 34·7 per cent. coming from Norway, 30 per cent. from Germany, 14 per cent. from Sweden, and 9·5 per cent. from Belgium, the remainder coming from the United States and other countries. The imports of printing and writing papers (on reels and not on reels) from the various countries in 1913 were in the following proportions: Norway, 33·9 per cent.; Newfoundland (entirely "on reels"), 17·4 per cent.; Sweden, 16·2 per cent.; Germany, 13·5 per cent.; Belgium, 2·6 per cent.; United States, 2·3 per cent.; "other countries," including, presumably, Austria, Italy, and Canada, 8 per cent.

The foregoing are the figures for what may, for present purposes, be considered a normal pre-war year (1913), and it will be useful and interesting to compare with them the percentages of imports of the same kinds of paper in 1915, a full year of war. As was to be expected, there was a considerable shrinkage in imports of paper and boards last year compared with that of 1913, the total amounting to 586,322 tons, as against 644,087 tons. Paper on reels showed a decrease of nearly 29,750 tons, the total imported being 106,720 tons. Of these Newfoundland contributed 44·7 per cent., Norway 30·3 per cent., Sweden 11·2 per cent., the United States 4·6 per cent., and "other countries" 9 per cent. For the first time in the history of the paper trade Newfoundland took premier position as an exporter to this country of paper on reels, the total amount being 47,789 tons, 15,410 tons in excess of those from Norway.

"Paper not on reels" was imported to the extent of 32,450 tons, being but 65 per cent. of the imports of similar paper in 1913, the percentage of Norway being 44·2, Sweden 26·3, Belgium 5·1, the United States 4·7, and "other countries" 19·1. It will, therefore, be seen that of the combined imports of printing and writing papers 34·7 per cent. came from Newfoundland, 33·5 per cent. from Norway, 14·5 from Sweden, 4·7 from the United States, and 11·3 from "other countries," which included Holland, Italy, etc. A cursory comparison of the statistics indicates that while Germany has, of course, been a sealed book, so far as imports are concerned, this country has to a large extent maintained its supplies from Norway and Sweden to within slightly more than 26 per cent. of those of 1913. The United States contributed last year over 51 per cent. more than two years ago, Newfoundland 11 per cent. more, and "other countries" 7·5 per cent. Belgium, though under the iron heel of her oppressors, managed to send us rather more than 34 per cent. of her normal quantity as represented by the figures for 1913. But it is evident that we must not expect any more from Belgium until the termination of the war, seeing that Germany has now prohibited exports of paper from that country.

With regard to paperhangings, imports in 1913 amounted in the aggregate to 2,865 tons, Germany's contribution being approximately

66·4 per cent., Belgium's 26·2 per cent., and "other countries" 7 per cent. In 1915 imports totalled but 169½ tons, 44 cwts. coming from Germany, none from Belgium, and 167 tons from other countries. Compared with 1913, when of the total imports of "other printed or coated papers" 52·7 per cent. came from Germany and 33·3 per cent. from Belgium, the figures for 1915 show a decline of 56·4 per cent., the total being 2,317 tons, of which no less than 67·3 per cent. came from Belgium, the remainder being divided between France, the United States, and other countries.

Imports of "packing and wrapping papers" in 1913 reached 204,514 tons, of which 33·4 per cent. came from Sweden, about 26 per cent. from Norway, 21·5 per cent. from Germany, 6·8 per cent. from Belgium, 6·4 per cent. from Russia (Finland), and 5·1 per cent. from "other countries." Last year 180,460 tons were imported. A negligible quantity, 418 cwts., seems to have reached this country from Germany, while Belgium's share fell to 1·6 per cent., and Russia's to 0·44 per cent. To a large extent these defections were balanced by increased supplies from Sweden, Norway, and "other countries," the respective percentages being 45·4, 42·8, and 9·5.

Strawboard, mainly the product of Holland and partly of the United States, though hitherto Germany and Austria have also exported these goods to us, totalled 176,500 tons in 1913 and 191,100 tons in 1915, while imports of millboards and wood-pulp boards, from the Scandinavian countries mainly, which in 1913 reached 65,950 tons, amounted last year to nearly 60,650 tons. Unenumerated classes and articles of paper were imported to the extent of 12,400 tons, an increase of 40 per cent. upon the returns for 1913. Almost the whole of this business has undoubtedly been done under the nose of the enemy's great war fleet, checkmated so wonderfully and effectually by the constant watchfulness of our own incomparable fleet, every overseas' route being strongly guarded by those whose duty it is to direct the British Navy to keep open for ourselves and our friends the waterways of the world for the benefit of its commerce, inward and outward.

Exports.

The effect of the war upon Britain's export trade in paper, etc., cannot be said to have been at all disastrous. The total exports of paper, boards, etc., in 1914 were 3,124,306 cwts., and last year 2,759,299 cwts., as against 3,498,914 cwts. in 1913. This must be considered an exceedingly favourable comparison under the circumstances, indicating as it does that, notwithstanding the loss of the German and Austrian markets, the dislocation of trade generally, shipping difficulties, and the restriction of output following upon so large a number of workers having joined the Colours, British paper manufacturers have been able to maintain their export trade to within about 21 per cent. of normal. Exports of British writing papers, as a matter of fact, were of practically average volume, being less than 4 per cent. below the total of 1913, while those of printing papers were 22·4 per cent. below the level of two years ago. Of these two kinds of paper 65·7 per cent. went to various parts of the British Empire, our largest customers being Australia, British India, New Zealand, and South Africa, 7·6 per cent. going to France, and the remainder to the United States and other foreign countries.

Our exports of packing and wrapping papers last year amounted to 36,281 tons, compared with 45,272 tons in 1913, those of printed paper-hangings to 4,192 tons as against 6,393 tons two years ago, and other printed or coated papers to 1,033 tons compared with 1,400 tons in 1913. Exports of pasteboard, millboard, and cardboard declined in 1915 by 40 per cent., manufactures of pasteboard, millboard and cardboard by 19 per cent., envelopes by 20 per cent., and bags by 8 per cent., while those exports of paper coming under the designation "unenumerated" decreased by nearly 14 per cent., due entirely to the falling-off of exports to France, the United States, and other foreign countries, those to the British Dominions showing an advance of 8·5 per cent. It must be borne in mind that the fact of our paper-makers being called upon to meet a heavier home demand for their production has naturally caused a contraction of their export business.

Pre-War Trade with Germany and Austria.

The extent of this country's pre-war trade in paper with Germany and Austria-Hungary has been dealt with in detail by the Commercial Intelligence Branch of the Board of Trade, which, towards the end of 1914, issued a statement dealing with the exports of paper, pasteboard and cardboard from those countries to the United Kingdom in 1912 and 1913. This showed our imports of paper, cardboard, etc., from Germany in 1912 were of the value of £1,286,000, while those from Austria-Hungary in 1913 were valued at £43,300. British exports in the same years to Germany and Austria-

Hungary were valued at £81,600 and £7,100 respectively. In addition, Germany's exports of paper, etc., to the principal colonial and neutral markets reached £3,602,850, those of Austria-Hungary £770,055, and those of the United Kingdom to £2,488,357. In 1912 the total value of German exports of paper, etc., to the British Empire, including Egypt, was something like £1,525,600; and those of Austria-Hungary in 1913, £165,945. It will thus be seen that the Dominions over which the flag of England flies were a rich field for commercial enterprise on the part of the paper and board manufacturers of the Central Powers. In no other country was Germany presented with such a market for her manufactures.

The various descriptions of paper, pasteboard, and cardboard imported by the United Kingdom alone from Germany were numerous, and are classified under no fewer than eighteen groups. Packing paper, including tissues weighing more than 30 grammes per square metre, and yellow straw paper, heads the list, being of the value of £492,000, coloured papers coming next at £168,400. Printing papers followed to the value of £140,600, and other products and their values were: Wallpaper, £72,500; pasteboard (imitation leatherboard), strawboard, wrapper-board, peat-board, etc., £65,300; parchment paper, £53,700; tissue paper (not used for packing), £47,200; paper and cardboard, punched or stamped out, £43,800; crude photographic (not treated with baryta), felt paper, etc., £34,700; gelatine paper, tracing paper, blue paper, fly-paper, test and other chemical paper, £28,700; lacquered paper, paper coated with scales of mica, glass, or wool, etc., £19,600; pasteboard of all kinds coated with white or colours with paper pasted on, varnished, etc., painters' boards, etc., £18,600; glazed boards, etc., £8,600; paper and cardboard covered with spun material, etc., £6,400; pasteboard impregnated with asphalt, for roofing, etc., ship felt for caulking, £3,000; slate paper, smoothing and polishing paper, £2,100; and vulcanised fibre, £1,100.

Austro-Hungarian exports of paper, etc., to the United Kingdom in 1913 embraced the following: Cigarette papers (plain and ribbed), £15,670; copying paper, tissue paper, etc., £6,820; packing paper (dyed and not dyed), £6,860; pasteboard of wood pulp, £4,745; drawing paper, artists' boards, and copper-plate printing paper, £2,400; lace and other perforated paper, £1,670; printing paper, £1,130; parchment paper, £395; coloured paper, etc., £190; common pasteboard, £110; fine cardboards (cartons), £40; all other cardboards, £20; wallpaper, £20; and various other papers not specially mentioned, £3,230.

Raw Materials, Labour, etc.

Coming to the question of our supplies of paper-making materials—wood pulp, esparto and rags—for which we are mainly dependent upon outside sources, comparison with the returns for 1913 shows that this country's imports of rags, which are used in the manufacture of the best classes of paper, declined last year by over 62 per cent., while in esparto there was a fall of nearly 33 per cent. As a consequence the difficulties of manufacturers of the better classes of paper have been, and are, extremely serious. Rags have materially advanced in price, and the increasing paucity of the supply foreshadows probable further advances. At the moment it is impossible to quote with any degree of certainty for any grade for a period ahead. Foreign rags, I understand, are practically unobtainable, while the demand for rags, ropes, bagging, and waste-papers of all kinds is very strong.

With regard to esparto, of which in normal times something like 200,000 tons is annually imported, great inconvenience and anxiety have during the past year been experienced through lack of supplies. About 50 per cent. of these come from Algeria and about 20 per cent. from Spain. Last year there was a shortage of 60,000 tons, which was chiefly due to the totally inadequate supply of transport, though a contributing factor was the diminished production of esparto in the growing countries. According to Messrs. Ide & Christie, "all varieties have shared in the shortage, but not all in the same proportion, the greatest falling-off, relatively, having been in Tunisian." Generally speaking, the course of the market has been steadily and persistently towards a higher level of prices, and the question of transport becomes increasingly serious day by day. Freight rates have been quadrupled since August, 1914, while the lack of tonnage and delays in loading are paralysing in their effects.

The record of the last two years is much more satisfactory when we come to consider the supplies of chemical and mechanical pulp. These have practically been maintained at normal levels, the returns for 1914 being actually 12,500 tons in advance of those for 1913, and those for 1915 being only 23,700 tons less than two years ago. Britain's command

of the sea is nowhere more clearly demonstrated than in the fact that, the German fleet notwithstanding, our supplies of wood pulp from the Scandinavian countries were in 1914 nearly 2,000 tons in advance of those in 1913, while last year they were actually 16 per cent. more than two years ago. In pre-war times our purchases of unbleached chemical pulp from Germany averaged 33,000 tons annually, but British paper manufacturers have suffered little, if any, inconvenience from the cessation of supplies from the Fatherland. Prices of all kinds of wood-pulp have undoubtedly advanced, partly owing to the increased cost of insurance and freight and partly to the greater cost of production in the exporting countries. Roughly, sulphite pulps have risen by from 60 to 70 per cent., and the price of mechanical pulps is nearly double the figure attained before the war.

Then, in addition to the increased cost of what I may describe as the staple raw materials, other factors operating in the direction of forcing up prices of paper, etc., are to be found in the greatly increased cost of coal, labour, chemicals, dyes, felts, wires, machinery, etc. Some of these had already begun to make their influence felt before the outbreak of war, and in this connection it may be mentioned that under the ægis of the Paper Makers' Association of Great Britain and Ireland something was done through mutual action and co-operation between competing firms to remedy what was undoubtedly becoming an intolerable situation, the continuance of which would render the paper-making industry of this country no longer a sound commercial proposition. The increased cost of coal and labour particularly had already compelled British paper manufacturers in self-defence to seriously face the question of advancing the prices of their productions, when war brought other difficulties in the train of those which may have been considered mainly domestic. Quite a number of subsidiary substances used in the process of the manufacture of paper became difficult and expensive to procure. The dye problem, for instance, quickly became acute, so much so that heavily-coloured papers have been to a very large extent discarded, the manufacture of those of lighter tints being resorted to from reasons of economy. Aniline and other synthetic dyes had been imported almost exclusively, if not entirely, from the Continent, and the extent of the shortage which developed may be estimated from the fact that, while imports in 1913 amounted to 283,027 cwts., the quantity obtained by this country last year was only 5,431 cwts. Dyes which used to cost about 3*s.* per lb. rose to 20*s.* and 25*s.* per lb. Some colours, too, which in the first half of 1914 were quoted at 1*s.* 6*d.* to 1*s.* 9*d.* per lb., have been sold at 60*s.* and 65*s.* per lb. Efforts are being made, chiefly through the agency of British Dyes, Ltd., a great concern fostered by our Government, to manufacture these dyes in this country, but naturally some time must elapse before we can expect the home production to meet the requirements of the textile, paper-making, and other industries of the United Kingdom, though there seems little doubt that we are gradually attaining a position of independence in this respect. But here again is another unfortunate result of British conservatism and prejudice, remarkable, too, when it is borne in mind that an Englishman (Sir William Perkin) invented aniline dyes from coal tar in this country, though it was left for German scientists to develop the principle and establish an industrial monopoly upon which every manufacturing country in the world has become more or less dependent, incidentally producing in Germany many multi-millionaires.

Chemicals, such as sulphate of alumina, powdered bisulphate of soda, sulphate of barium, and anhydrous sulphite of alumina, formerly obtained from Germany, advanced greatly in price, and certain classes of glue and gelatine and other sizing materials, in which Germany had almost a monopoly, became hard to obtain. Bleaching powder has also been scarce, and quotations which reached about £5 10*s.* before the war rose to £7 10*s.*, and afterwards to £10 and £14 per ton. Indeed, buyers have been heard of offering as much as £25 per ton, without being able to obtain what they required. Government requirements and the stoppage of German and Belgian competition were undoubtedly the chief causes of these great advances. Alkali, for which this country has been famous, has had so many calls upon it through the absence of foreign competition that it has advanced materially in price, and manufacturers have for many months experienced much difficulty with regard to transport both by sea and rail. Freight room in coastwise steamers became unobtainable, and the supply of railway waggons has been nothing like equal to the demand, while even after loading enormous delays have occurred in transit.

In this connection I should like to pay a tribute to the loyal and patriotic manner in which such world-famous firms as the United Alkali Co., Brunner, Mond & Co., the Castner-

Kellner Co., and the Ammonia Soda Co., Ltd., have treated their customers. They have all systematically refused large and tempting offers of new business from various foreign countries, considering it to be their duty to keep all their paper-making customers well supplied. Indeed, I believe that in order to ensure stability of business in this country they offered all users of bleaching powder three years' contracts at normal prices, of which considerate offer the bulk of consumers naturally took advantage.

Prices of caustic soda also have gone up to a high figure. I am informed that nominally the advance since the outbreak of war is about £3 10*s.* per ton, but sales have been heard of which show advances of at least £15 per ton. There is no doubt that there is a shortage all round of caustic soda, and so long as this continues prices are bound to rule high, and naturally those paper-makers who are dependent upon caustic soda alone will suffer greatly.

Zinc plates, extensively used by paper-makers for glazing, were chiefly the production of Germany, and resort in some cases had to be made to the use of thin nickel-faced steel plates, which I was instrumental in advocating early last year. They are, of course, more expensive, but are certainly more durable.

Paper-machine wires also became scarce, and prices have for some time been much higher than in pre-war times. The Germans had captured the bulk of the paper-machine wire business, their price being about 8½*d.* per square foot for export, taking care to make their own paper-makers pay a good price for their wires. But worse than this, they had practically cornered the manufacture of the drawn wire used by the British and most other paper-machine wire makers.

A considerable and increasing business was done up to the declaration of war with Germany and Austria-Hungary in woollen felts for clothing paper-machines, the same *modus operandi* being employed as in the case of the paper-machine wire weavers.

With regard to China clay, difficulties have arisen, not so much as to production but as to railway transport, and prices generally have not advanced so much as might have been anticipated.

An important and steadily developing trade was being done by the German engineers with the paper-mills of the British Empire, notably in sheet, friction, and glazing calenders of all kinds used in the trade, a speciality in which the Germans excelled. The whole of the plants, I might say, used in British mills for coating paper and printing machinery to a large extent were supplied by German engineers as well as many other paper-mill equipment specialities made and supplied by German engineering concerns.

There is reason to hope, however, that British paper-mill engineers will in future command a more important share of orders for this machinery than in the past. During the last twenty years British engineers have played an increasingly prominent part in the equipment of paper-mills, and it is not too much to say that in skill, resourcefulness and workmanship they have proved themselves to be at least the equals of their Continental and American rivals. During the past year or more their plants have been chiefly engaged upon munitions work, but it is satisfactory to learn that the cessation of war's alarms is already being anticipated in numerous inquiries from neutral and allied European countries as well as China and Japan, the United States and Canada, and I have no doubt that a bright and prosperous future awaits the British paper-makers' engineer. This remark, by the way, should also apply to our electrical engineers, who have no reason to be ashamed of the work which they have carried out in the past in the installation of electrical plant in paper-mills.

Yet another important factor in the situation which has arisen has been the greatly increased cost of labour. I do not think it is overstating the case to say that wages in paper-mills have advanced by about 20 per cent. The shortage of skilled labour in paper-mills owing to our military requirements has also presented difficulties of a somewhat serious nature. In some mills output was temporarily reduced to a considerable degree, but this is steadily being remedied, and there seems no reason to doubt that British paper-mills are now so organised that these difficulties are rapidly disappearing, the skilled hands having been "starred"—that is to say, exempt from military or naval service.

Prices, etc.

The abnormal conditions of which I have endeavoured to give a brief outline have naturally tended in the direction of enormously increasing the cost of the production of paper. This, coupled with the growing demand and interference with supply, has necessarily involved an advance in prices. Stocks in this country were fairly large at the time of the outbreak of war, but almost immediately afterwards prices began to harden perceptibly. As a matter of fact, the general conditions governing

the situation could not be accurately predicted, for the position in many respects was without precedent. No one could estimate, for instance, how far and for how long supplies of raw materials and manufactured paper from abroad would be affected by the action of the German fleet, and our ideas as to what might happen were of the most crude and chaotic character. Panic, happily short-lived, actually began to seize many sections of the paper trade. "News," which had been sold at 1*d.* per lb., mounted to 2*d.*, and several other grades began to advance in price. Wiser counsels, however, soon prevailed, and the market quickly steadied itself. During the early months of the war prices went up only from 2 to 5 per cent., but as time went on further advances were made, and by the end of last year it might be said that the average advance in prices of the usual run of printing and writing papers was from 40 to 50 per cent. beyond those prevailing in pre-war times. White machine-glazed poster papers, which used to be obtained for about 18*s.* 6*d.* per cwt., rose to 30*s.*, but this may well have been due to the fact that the Government demand for this class of paper for recruiting purposes rendered it difficult for private consumers to obtain supplies. One may, therefore, incidentally suggest that with the advent of compulsion for the unmarried "shirkers" the necessity for recruiting posters disappears, and thus the situation with regard to machine-glazed printings is relieved. Cheap super-calendered printings, sold eighteen months ago at 1¼*d.*, are now being quoted at 2½*d.* and 3*d.* per lb., no guarantee being given as to exactness of shade; better-class super-calendered papers normally selling at 2½*d.* are being snapped up at 3½*d.* to 5*d.* per lb.; glazed tints at 3*d.* have displaced foreign productions at 1½*d.* "News" paper, obtainable at 1*d.* per lb. before the war, now costs 1¾*d.* and even 1⅞*d.* Even 2*d.* is being asked in some quarters. This is a serious matter for newspaper proprietors, whose expenses are increasing in every department. Printing costs are up from 10 per cent. to 15 per cent. alone, while the revenue from advertisements appears to be getting less and less.

Imitation art papers have risen during the last two or three months from 2¾*d.* to 4¼*d.* net, and art papers (coated) have advanced from 3¼*d.* to 6*d.* per lb., and practically all along the line prices are up. Manufacturers of brown papers are just now experiencing a phenomenally heavy demand, notwithstanding that quotations are nearly 100 per cent. higher than eighteen months ago. Wrapping and packing papers are, indeed, not unlikely to reach famine prices, seeing that manufacturers are quite unable to meet the huge requirements of the public within reasonable time. Speaking as a large consumer of paper and with a lifetime experience of the paper trade, I must say I view with alarm any undue tendency to raise prices. As it is, the present prices are bound to result in a greatly restricted consumption on the part of newspaper, magazine, and book publishers.

The scarcity of boards used by our paper-boxmakers and the consequent increase in the price of same is handicapping our boxmakers not a little; also the high price of girl labour, brought about by the tempting wages to be earned in the munition factories. The same trouble is also to be found in the expensive business of paper-bag making.

The Restriction of Imports of Pulp and Paper.

Since preparing the foregoing portions of this paper the paper trade of this country has reached a crisis of considerable gravity. This arises (1) from the action of the Swedish Government in prohibiting the exportation of chemical pulp, and (2) the decision of our own Government to restrict imports of wood pulp and other paper-making materials and manufactured paper in order to relieve the pressure upon this country's shipping facilities. It is not my intention to investigate the reasons for these important steps, but rather to estimate the effect upon the British paper-making industry and paper trade. As to the Swedish embargo on chemical pulp, I would, however, say that, without disputing Sweden's right to take any steps she may deem necessary in protecting her own interests, I share the views of many others in this country that her prohibition of exports of chemical pulp savours very much of bluff, and is not in the best interests of the Swedish people.

That, however, is a matter which must be left to the judgment of Sweden herself, and all that we are called upon to consider is the influence of the embargo upon our paper-making, paper-selling, and paper-consuming trades. Adopting that view, the Swedish prohibition is overshadowed by the larger policy upon which the British Government have entered in the restriction of imports of all paper-making materials and paper, the effect of which will undoubtedly be serious and extensive.

At this stage let me pay tribute to the patriotic

attitude adopted by the Paper Makers' Association of Great Britain and Ireland in asserting that if, in the opinion of his Majesty's advisers, it is necessary to curtail the import of raw material and the export of the manufactured article, in order to release shipping for our national needs, the trade which in a corporate capacity it represents will cheerfully acquiesce in the arrangement. Our hearty concurrence with that attitude, however, need not prevent us examining for a few moments the effect of the Government's policy upon the British paper-making industry and the allied trades.

In this connection it must not be forgotten that just as wood pulp, esparto and rags are the raw materials for the manufacture of paper, so paper is the raw material for the production of numerous commodities which enter largely into the daily life of the people. It has been somewhat of a revelation to me to realise the widespread ignorance which has hitherto prevailed as to the manifold uses of paper. To that important individual, the man in the street, paper was mainly associated with the production of newspapers, books, magazines, etc., writing and wrapping papers; but, as a matter of fact, there are many distinct industries upon which great hardship will be inflicted by the curtailment of their supplies of paper and boards. Among these may be mentioned those devoted to the manufacture of paper boxes and paper bags, sand paper, cop tubes, slippers, loom and Jacquard cards, cartridge cases, cigarettes, paper collars, greeting cards, gun wadding, insulators, photographic mounts, and many other articles, while the bookbinding industry must not be omitted. It will thus be seen that any interference with their supplies of paper and boards must seriously affect many important and useful trades.

Upon British paper-makers the restriction of imports of pulp and other raw materials must press heavily, particularly upon those who have laid down machinery and plant for the production of certain kinds and qualities of paper which, prior to the war, were not made in this country at all. Many of these, I believe, have been able to capture a great deal of what used to be German trade, and it is, therefore, regrettable that the necessity should have arisen for interfering with the development of what may be regarded as a new feature in British paper-manufacturing operations.

Broadly speaking, it is doubtful whether any action of a similar character which the Government could have taken would have exerted so paralysing an effect over such a wide field, and would have injured so many undertakings as in the case of the paper-making industry. There are already signs of confusion in almost every quarter where paper is used, and particularly where German specialities have not yet been replaced or supplanted by British products. The restriction of their supplies of necessary raw materials comes, too, at a time when British paper-mills, notwithstanding the reduction of their operative staffs, are working at practically their full capacity, and the reduction of their output by a considerable percentage must inevitably entail hardships of a serious nature.

The Government's action must, of course, lead to the necessity of the exercise of strict economy in the use of all kinds of paper. Stocks are now very large, but they are not inexhaustible, and the general public must resign itself to many sacrifices. Our newspapers will undoubtedly be reduced in size and embrace fewer editions; our business and personal correspondence may have to be curtailed; and in numerous other directions which I need not trouble to specify the watchword in all departments of public, commercial, and private life must be—economy!

At the time of writing, it is not known what the scope of the Government's action will be, but as an indication that some drastic step is contemplated, it is significant that inquiries are being made among printers and others in this country with a view to ascertaining the extent of their stocks of paper.

The Influence of Freights.

If time permitted it might be worth while to say something regarding the difficulties and the costliness of freights. This, as a matter of fact, is one of the most important influences affecting the paper trade of the world to-day. It is no secret, of course, that the real difficulty is in regard to "bottoms"—in other words, ships; and this, together with the equally serious problem of railway transit, is, as probably most of you are aware, receiving the serious attention of our Government at this moment. Whilst making every possible allowance for the imperative demands of the Government, a condition of things we must all loyally respect, an authority recently commented somewhat strongly on the avoidable delays, particularly in regard to shipping.

It seems to be admitted that there has been a good deal of muddling and misuse with regard

to our shipping—in other words, we have not put it to its best use; and surely there must be something wrong if, as is stated, roughly 25 per cent. of our ships' time is occupied in dock upon work incidental to discharging and loading.

No doubt labour difficulties and extraordinary demands on space and accommodation have much to do with this, but it is suggested by those who should know that we are by no means up to date, particularly in certain ports, in regard to labour-saving appliances and the application of the most modern haulage appliances. Misapplication of existing organisations, incompetency on the part of higher officials appointed by Government to supervise the mercantile marine of this country, coupled with lack of experience, is largely responsible for a great deal of "muddling."

It is difficult to appreciate fully how much we owe to the efficiency and activity of our Navy, and, bearing this in mind, it is unfortunate that the unquestionable advantages we owe to this all-important superiority should, in a sense, be wasted by delays which are apparently to some extent quite unnecessary and avoidable.

All traders also realise the terrible condition of things arising from the congestion of our railways. I have no desire to be unduly critical at a time when the demands of our fighting forces must take precedence. Still, I do feel that manufacturers, merchants, and consumers have just cause for complaint in regard to some of the extraordinary delays on our railways, delays which have caused and are causing tremendous inconvenience and enormous losses. It is not consoling to be told that matters may even become worse. If some of the tales I have heard regarding the time occupied in carrying urgent matter a comparatively short distance are correct, and I believe they are, in my opinion it is time that the question should be considered by a competent body, as the opinion seems to be general that, without interfering in any way with Government demands, a great improvement might be made in regard to this all-important matter, which has had a very serious effect on many paper-mills, and on those who rely on regular supplies of paper for carrying on their businesses.

In regard to shipping, it is rather refreshing to have the authority of Sir Walter Runciman "that the cost of freightage is not only scandalous, but a crime." This admission, coming from such an eminent shipping man, is, to say the least, significant.

THE BRITISH EMPIRE'S RESOURCES IN PAPER-MAKING MATERIALS.

Seldom has this country's dependence upon foreign sources for its supply of raw materials been more forcibly brought to mind than by Sweden's action in prohibiting the export of chemical pulp, and never has the nation been so vividly reminded of those vast resources which are to be found within the limits of the Empire which it has established. I need scarcely remind you that about nine months ago the Royal Society of Arts did me the honour of affording me the opportunity of submitting a paper on this subject, and perhaps you will pardon me for recalling that on that occasion I mentioned that our dependence upon the Scandinavian countries for supplies of chemical and mechanical pulp had not been without a certain amount of risk to the interests of the British paper-making industries. I then urged that we should endeavour to supplement our foreign sources of supply with those which are awaiting exploitation and development within our own world-wide Empire, and in the course of my paper I dealt at some length with the wonderful potentialities of the Dominion of Canada.

It is, however, unnecessary for me to traverse that ground again, except to state that the latest estimates of the Forestry Branch of the Department of the Interior show that the value of Canadian pulpwood in 1914 was placed at $60,500,000, an advance of $5,500,000 upon that of 1913. In the manufacture of pulp 1,224,376 cords of wood were used in 1914, and of this 68 per cent. was spruce, 25 per cent. balsam fir, 3 per cent. hemlock, and nearly 2 per cent. Jack pine, the balance being poplar. The production consisted of 644,924 tons of mechanical pulp, 217,550 tons of sulphite, 70,333 tons of sulphate, and 1,893 tons of soda pulp. These returns indicate that the production during 1914 of all kinds of pulp in Canada was nearly 20,000 tons below the quantity of wood pulp imported by the United Kingdom in 1915. It will, therefore, be seen that some time must elapse before Canada is in a position to furnish this country with even a moderate proportion of its supplies of either chemical or mechanical pulps, after satisfying its own requirements. And in this connection it must be borne in mind that Canada is steadily developing its own paper-making industry, and during the fiscal year ended March 31st, 1915, exported paper to the value of $15,478,338. During the same period the Dominion also exported more than 240,330 tons of chemical pulp, the great bulk

of which went to the United States, and nearly 223,000 tons of mechanical pulp, of which 64 per cent. was absorbed by the United States and 33 per cent. by the United Kingdom.

It would, no doubt, be possible for Canada to increase materially her exports of wood pulp to this country at the expense of those to the United States, but under present conditions, when ocean freight rates are so high, it is probable that the cost would be greatly in excess of that from the Scandinavian countries. At present Canada is not in a position to take the place of Sweden as one of the two main sources of our supply of wood pulp, and cannot be expected to do so until after the expenditure of a large amount of capital in the erection and equipment of new pulp-mills and in the acquisition of pulpwood areas. All this must necessarily be a matter of time. In the case of sulphite pulp, of which Great Britain imports so large a quantity from Sweden, it must not be overlooked that at present Canada has only three mills, I believe, manufacturing it solely for exportation, and these produce in the aggregate less than 400 tons a day. In addition, there are a number of paper mills making sulphite for their own consumption, which can afford to export surplus quantities to a small degree. However, the extraordinary attitude assumed by Sweden will, I am certain, act as an incentive to Canadians to attract British and other capital for the development of the wood-pulp business in the interest of the Mother country.

With respect to Canada and the possibilities of Canada in regard to the wood-pulp question, I may say that I recently had the pleasure of meeting Mr. J. E. A. Dubuc, who is admittedly the greatest authority as a wood-pulp manufacturer in Canada. Mr. Dubuc has been in this country within the last day or two, and he was good enough to speak quite freely on the subject to me. He said that, as far as the export business is concerned—I am now referring to chemical wood-pulp—the three mills producing chemical pulp have invariably a surplus over and above their own requirements for their own respective mills. I put several leading questions to Mr. Dubuc, and said: "Speaking with regard to chemical pulp, what do you consider are the possibilities with regard to increasing the production for export?" Mr. Dubuc replied, without any hesitation: "If the money could be put up to-morrow, I will guarantee that our production of 35,000 tons on the St. Lawrence, and the proposed production of the Ha-Ha Bay mill (another 35,000 tons), could, if necessary, easily be doubled."

I asked Mr. Dubuc how long it would take to achieve this, and he made the following interesting reply: "Well, I would undertake to furnish round about 200,000 tons of sulphite wood-pulp (including the present output) per annum in two years from now."

I mentioned the fact that certain paper-makers had expressed a fear that the supplies from present sources might possibly be interfered with by embargo or from other considerations after the war, and Mr. Dubuc said: "If the necessary capital were forthcoming, mills could be built on sites at present in my mind's eye, and the capabilities of these mills would, if necessary, be not less than half a million tons per annum, and this quantity could be drawn from just two sections of Canada, leaving out of consideration the enormous resources which, as you know, include illimitable timber reserves, stretching even beyond the pale of civilisation."

The general effect of Mr. Dubuc's replies were, without any qualification, that within a comparatively short time, providing the capital were available, Canada could unquestionably produce enough wood pulp for the paper-making requirements of the world.

Mr. F. E. R. Becker, of the firm of Becker & Co., another well-known authority on wood pulp, who was present when this conversation took place, endorsed the opinions Mr. Dubuc had expressed, and he observed that Chicoutimi, the great Canadian undertaking at present devoted to the production of mechanical wood, has 436 ft. fall, and has developed not more than 170 ft. of this enormous power. Mr. Becker added that Chicoutimi produces on this present development 350 tons dry mechanical pulp per day, and if the 436 ft. were developed Chicoutimi would turn out 1,000 tons dry per day, and 300 working days on this calculation would mean 300,000 tons dry mechanical pulp.

Mr. Becker added that this could be achieved in eighteen months, and it would mean more pulp of this class than the world uses in the open market.

It was also mentioned that, as regards the timber available, the Peribonca (Lake St. John district) alone contained 10,000 square miles of excellent timber, so that the timber problem need cause no concern.

I asked Mr. Dubuc how the shipping problem was to be solved, assuming these great developments were realised, and he said that if the British consumers were prepared to make ten-year contracts, as he had no doubt many of them would be prepared to do, the shipping

questions could readily be settled. He also said that the available country round the Saguenay and the Gaspé Rivers alone could provide all the pulp required by British mills.

I was interested to have this information on such high authority, for no persons have a more thorough knowledge of the subject than the two gentlemen I have mentioned.

What I have said with regard to Canada applies, in my judgment, with equal force to Newfoundland and Labrador, both of which are rich in pulpwood, and will eventually become enormous sources of supply.

Time does not permit of more than a passing allusion to those which are available in India, where vast quantities of bamboo, Savannah, and other grasses can be utilised in the production of paper; in Trinidad, British Africa, and the Federated Malay States. It is indisputable that within the borders of the British Empire there are enormous resources in paper-making materials, but their application to the requirements of British paper-mills cannot be effected in a day or a year. Many considerations enter into the question of their adaptability to the manufacture of paper in this country, and not the least important is that associated with the diverse mechanical methods with which wood pulp and pulp made from grasses, etc., are treated.

The question of utilising the Empire's resources in paper-making materials is, therefore, not quite so easy of settlement as some newspaper correspondents seem to imagine. That it will eventually be satisfactorily settled I have no doubt whatever, but only after the passage of some years and the expenditure of a large amount of capital.

If the Scandinavian wood-pulp producing countries show a disposition after the war to place embargoes on the export of wood pulp to this country, then, naturally, the problem of utilising the British Empire's resources in paper-making fibres will be solved much sooner.

In conclusion, I would add that the enormous virgin forests of Russia have yet to play a very important part in the manufacture and exportation of sulphite wood-pulp to this country. The Germans, by the erection of enormous plants in the Russian Baltic province of Courland, have produced for some years past, on a large scale, excellent cellulose from Russian pulpwood, the quality being fully equal to that of Scandinavian chemical pulp. I believe, however, these huge German mills have been destroyed by the Russians in the prosecution of the war.

It is probably within the knowledge of most people in this room that the *London Gazette* of yesterday evening contained a Proclamation prohibiting—

All materials for the manufacture of paper, including wood pulp, esparto, grass, and linen and cotton rags.

Paper and cardboard (including strawboard, pasteboard, millboard, and wood-pulp board), and manufactures of paper and cardboard.

All periodical publications exceeding sixteen pages in length imported otherwise than in single copies through the post.

With regard to the proposed restriction of imports, I hear, unofficially, it is probable the Commission will decide on a restriction of $33\frac{1}{3}$ per cent. If this is so, I think it may be considered a satisfactory compromise.

DISCUSSION.

THE CHAIRMAN (Lord Burnham) said the paper was an interesting and exhaustive one on a subject that had now become one of the burning questions of the day. A little while ago probably nobody in the country anticipated the steps that would be taken by the Government to restrict the importation of paper and paper-making materials. There was no more curious problem in psychology than the attitude of the public mind in this country to trade questions. Public ignorance was abysmal. It was not thought that trade questions ought to be considered by the general public, unless some political considerations were immediately involved. There was no disposition here, as in the United States, to hold constant conferences to consider matters of world trade in all their bearings, nor were the people instructed in the facts and figures as people had been for the last fifty years in the State-ridden Empire of Germany. Consequently, when a question like the restriction of the paper trade came into public prominence, there was absolutely no sort of appreciation on the part of the general public as to how matters stood or whither they would tend. The author had said that the public ignorance in regard to the paper trade astounded him, but he (the speaker) could not say that it astounded him; he verily believed that the general public imagined that the only trade in paper was that of the daily and weekly journals. Many people considered that it would not be a bad thing if a tax were placed on the shoulders of newspaper proprietors who were selling an unusual number of copies of their issues owing to war conditions. Of all the war fallacies he did not suppose there was a greater one. In the first place the war had spelt a huge loss, in some cases positive disaster, to the newspaper trade; but, apart from that, the newspaper trade was but a small part of the national industries which were concerned with the importation of paper and paper-making materials. The

paper industry was not only an essential trade in the country, it was practically a fundamental trade. Not only did it supply by means of books and papers the intelligence with which all other trades were carried on, fixing the price as it were of the intelligence department of British trade and industry, but paper was now used in so many trades that it ramified throughout the whole of the commercial and industrial organisations of the country and the Empire. He had been told only last week that owing to the sudden restriction placed upon the paper trade, the hosiery trade was suddenly arrested by the fact that it was impossible to obtain paper in which to wrap stockings. Many such examples could be given. It was an open secret that paper was used in making shells; the munitions trade of the country depended upon paper to a considerable extent, and thus paper was directly as well as indirectly the basis of a war industry. Without arguing the point as to whether restrictions ought or ought not to be made, he might say that it was very regrettable that the public—and he thought Parliament too—was not able to consider the question with a full knowledge of what it meant and whither it tended. It was well known that the necessity for restricting the importation of paper and paper-making materials had arisen from the want of bottoms in which to carry the general trade, and particularly the essential trade supplies, of the country, and not only of the country but of the whole of the nations which were included in our great alliance. It was not only a matter of our own shipping being taken for Government purposes; undoubtedly if neutral ships were released from part of their present burden of trade they would be available for other and perhaps more necessary purposes. The economic experiments in which the country was embarking under the stress of war were certain to lead to results which would be, if not damaging, at least disadvantageous to the country, and would have a serious, crippling effect upon many of its industries. It was a disadvantage, of course, that the export trade in paper and other kindred products was for the time put an end to, because, as was known on the highest authority, the greater our export trade the better for the balance of our trade all over the world, the better for our exchange, and the larger the resources available for war purposes. Therefore in itself, apart from the question of shipping, the prohibition of exports was a serious matter. In this country we produced no paper-making materials of first quality; the only thing that might be classed as paper-making material was the waste of the paper and other trades. That made the matter of price particularly difficult. Again, on the political side, nobody viewed with pleasure the curtailment of our trade with neutral countries, which was very largely to their advantage. As was well known, Sweden and Norway lived upon their timber, exported for various purposes in a raw state, and converted into wood pulp and paper as a finished article. Therefore, no one cared to see the present state of things, even though it was admitted that the first duty of the Government was to secure the greatest amount of shipping for the primary purposes of the war, both for our Allies and ourselves. Generally, the consequences of restriction were likely to be serious, but economy and thrift in the use of materials might do something to repair the damage, and if the information the author had was correct, the proposal to diminish the supplies by only one-third was a great improvement, from the point of view of those concerned in the paper trade, upon the first Government plan, which was said to be a diminution by 50 per cent. It would be much easier for the trade to readjust itself to the conditions if it had not to face so large a discrepancy. Looking to the future, there was no doubt that we ought to do our best to put our trade on an Imperial foundation. Roughly speaking, Norway and Sweden supplied nearly 75 per cent. of the raw material of paper, and although we did not wish to diminish trade with them we did wish, under the stimulus of war, that after the war our own dominions should have the lion's share. The proper meaning of economy was the "Law of the house." The Empire was a house of many mansions, and therefore it should be our aim to see that the Empire secured the greater part of the increase that was bound to come when we were supplying ourselves and the other parts of the Empire with the paper and paper products hitherto imported so largely from foreign countries. The whole question of Imperial trade was being looked at in a new light and from a different angle. We should not concern ourselves with the abstract merits of Free Trade and Protection, but should seek that security which could only be effected by making the Empire self-sufficient in all the main industries and the necessities of life. Paper was a necessity of life, a necessity in the larger sense; it was a necessity of communal life and of individual life; and those who were concerned with the paper industry must do their best to see that its foundations were so well and truly laid in the future that the industry could never be placed in the predicament it was now in, dependent, apart from the action of the Government, upon the will of foreign powers to limit or altogether to curtail the supply of the necessary material upon which the industry lived and thrived.

MR. CLAYTON BEADLE said the enormous development of the paper trade during recent years created a far greater problem during this time of war than it would have done in any previous period when the nation had been at war. One of the largest mills in this country produced more paper to-day than the whole of the United Kingdom produced a little more than one hundred years ago. During the Napoleonic wars all the Government of the time seemed to be able to do in the way of conserving the supply of rags was to prohibit the burial of the dead in linen shrouds.

The author had read his paper at the psychological moment; in fact, the moment was almost too opportune to enable the subject to be adequately discussed. He had heard of a case recently where, in order to secure a quick delivery, a penny a lb. was given, which amounted to about 30 per cent. advance on the price contracted for. During the last month he had been asked by cable from the colonies to ascertain whether certain papers were procurable in this country, and he was sorry to say that at the moment—although it was not true a month or two ago—the only answer was that they were not obtainable, and there was no possibility of finding out when the manufacturers here would be in a position to supply. The author had referred to several kinds of paper formerly manufactured in Germany, which had been already successfully produced in this country. One class of paper that had been exceedingly difficult to make, but the making of which had been completely mastered, was filter paper. Photographic and other special papers had also been produced by certain enterprising manufacturers who were producing other classes of paper before the war. There were still papers which came almost exclusively from Germany not yet manufactured in this country. The question of coloured papers was an extremely difficult one, and for certain purposes the use of coloured paper would have to be set aside until the termination of the war. Although the United States were making paper almost entirely for their own use, the cost of the manufacture of pulp and "news" in Canada was considerably less than the cost in the United States. That was largely due to the fact, he believed, that the supplies had not been depleted in Canada to anything like the same extent. The author's figure of 10,000,000 tons as the world's production of paper had been confirmed by another authority. The rate at which the consumption of paper had increased in different parts of the world was without precedent, and the increase was going on to an alarming extent, chiefly owing, he thought, to the enormous wastage from paper being so plentiful. He believed the exportation of rags had been prohibited as from March 1st. The Americans had been competitors in the rag market, and it had been very much to the detriment of buyers in this country that Americans had come over and bought large supplies and thus considerably inflated prices. It was therefore a good thing that the exportation was to be prohibited.

Mr. H. Whorlow (Secretary of the Newspaper Society) said he had been very much interested in the statement of the author as to the intention of the Government with regard to the proportion of imports to be restricted. The same information had reached him on the previous day from a very reliable source, and if it was true it would go a very long way towards relieving the great anxiety under which the newspapers of the country laboured at the present time in anticipation of the difficulties of a threatened famine. He had just issued a circular giving a general statement of the present position of affairs, and in that circular had mentioned the proportion of 50 per cent. If the reduction was to be to one-third, he believed it would be to a very large extent due to the efforts of Lord Burnham himself and the stand he took at an early stage of the matter. When the Paper Commission met they would have many difficult problems to face, one of which would be to devise some means whereby publications of all kinds would get a fair proportion of paper to meet their requirements. There had been some talk of a compulsory reduction in the size of newspapers, but it seemed to him it was very unlikely that the Commission would go to work in that way. When the war first broke out there was some panic, and many papers, especially weekly papers, reduced their size from sixteen to eight pages, and from eight pages to four pages, while others continued to publish the same size as before. In a town where, say, three newspapers were published, if one had cut down its size while its contemporaries continued to publish on the old lines, that fact ought to be taken into account when the allotment of supplies was made, if there was any intention compulsorily to limit size. An ordinary eight-page weekly paper could not do with four pages, as it would be impossible to publish advertisements. Newspapers which had anticipated economy should not be put on the same level in allotting supplies as those which had made no reduction in size at all. It was a satisfactory augury for the success of the Commission that everybody entertained the utmost confidence in the fairness and ability of its Chairman, Sir Thomas Whittaker.

Mr. Percival Marshall said that as one of the unfortunate paper-consuming public he naturally regarded the present situation as being very serious, and he had felt somewhat relieved when the author said that there was a possibility of the original restriction being relaxed. If only one-third of the paper supply was to be cut down then the economies which might be effected in many ways, by newspapers and other large users of paper and by the public generally, might go a long way towards making up the deficit. With regard to the point of the Swedish restriction being a piece of diplomatic bluff, it occurred to him that it might be a very good thing if the author's remarks upon the possibilities of Canadian production could be brought in a suitable way to the notice of the Swedish Government. No doubt they were quite aware of the possibilities of Canada in the way of producing paper-making materials, but the author had thrown some further light on the subject, and the conversations he had had with Canadian representatives as to the readiness of Canadian manufacturers to fill the gap might, if brought to the notice of the Swedish authorities, have some effect upon them. It might be possible for some of the editors of the

country to set an example to the public in economy by allowing their contributors to write on both sides of the paper.

THE CHAIRMAN said a difficulty would then arise with the compositors, who did not allow writing on both sides of the manuscript.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to the author.

MR. S. CHARLES PHILLIPS, in reply, thanked the audience for having borne so patiently with the length of the paper. He could assure them that the only trouble he had had was as to how much he could get through in the time. He thanked Lord Burnham for presiding. Everyone was delighted to see his lordship. Personally, he took it as an exceedingly delicate and kind compliment to himself, because Lord Burnham was the proprietor of the *Daily Telegraph*, one of the largest, most important, and most influential papers in the world, a paper of which the country was proud, and he was also a very large and important paper-maker, as the *Daily Telegraph* possessed its own mills at Dartford.

MR. PHILLIPS has since sent the following note on the question of rag supplies:—"A gentleman who is admittedly a leading authority on the subject of rags for paper-makers' requirements, and on other classes of paper stock, tells me that the collections of both rags and waste-papers have fallen off to a considerable extent, owing largely to the fact that a considerable number of small collectors have gone to the war. I also learn that the question of price for rags for paper-making has almost ceased to be a matter of consideration, and that 'send on the goods and charge whatever you think is reasonable' is quite a common instruction on the part of paper-makers nowadays. This condition of things is, of course, directly attributable to the war, and my informant observes that it would be a very pleasant thing for the dealers if they had the material to dispose of on these terms. I also learn on the same authority that it is questionable whether the proposed restriction on the export of linen and cotton rags and waste-papers will help matters to any appreciable extent. It is an interesting fact that shortly after the war started common waste-papers were a complete drug on the market—in fact, a large London dealer said he was prepared to give away barge-loads for nothing. Latterly, however, owing to the demand first from Holland, then from France, things have changed materially."

CORRESPONDENCE.

THE ORGANISATION OF SCIENTIFIC RESEARCH.

DR. J. A. FLEMING, F.R.S., writes in reply to the discussion on his paper read at the meeting of February 9th:—"I esteem myself fortunate in having been able to elicit from so many eminent scientific men expressions of opinion on this subject which they have deeply studied. It is also satisfactory to find that there are several points on which we are all in general agreement, even though differing on others. One of these is that it is essential to distinguish very carefully between the nature and aims of (1) pure scientific research, (2) technical or industrial research, and (3) practical or useful inventions. The public and the press only too frequently confuse them. As regards pure scientific research, from one point of view it is merely a delightful and interesting occupation or pursuit to those who have the necessary tastes and mental qualities, and if it had no other aspect there is no particular reason why the State should be called upon to assist it. But as a matter of fact it is the basis on which technical research and invention rest; and, moreover, the three, though broadly speaking distinct, shade into each other so finely that it is difficult to draw hard and sharp lines. Hence no nation can say it will only foster technology and invention, but leave pure science alone. The general principle has been accepted and acted upon that the State, that is the nation, should financially assist pure scientific research regardless of any immediate industrial applications as a matter of high public policy. The questions at issue are then—to what extent it should assist it, and by what means. My contention is that the State should do this only by putting funds for this purpose at the disposal of properly qualified scientific men or bodies and leave them to settle how they will employ it. The State should not meddle with details, and above all should not establish any bureaucratic control over pure scientific research. The very essence of scientific work is intellectual liberty, and science must not bargain away its freedom for any mess of State pottage. If a bureaucratic control of research is allowed to grow up, then it will not be long before those few who have the necessary gifts and powers of mind for making scientific discoveries or researches will find themselves bound hand and foot by bandages of red-tape, and their freedom crippled by a number of officials who might not have either the ability or the wisdom to do the right thing. Hence it is satisfactory to note that the opinion of most of those who have spoken in this discussion is decidedly against detailed control of research by Government committees or departments. The only safe way to assist it is by placing the necessary means in the hands of men who have already exhibited great capacity for doing scientific research. Personally I think that one good way of doing this is the creation and multiplication of such positions as the Research Professorships of the Royal Institution, in which opportunities for research are coupled with no other obligations than those of expounding at intervals to public audiences the results of investigations. Moreover, a life service to the nation in such a position should carry with it a right to a pension,

so that there should be no necessity for the occupants of these chairs to engage, as did Faraday and Tyndall, in outside teaching or consultative work to secure the means of independence in declining years. As regards younger men, I believe that a considerable extension of research scholarships, on the lines of the 1851 Exhibition Scholarships or Whitworth Scholarships, would prove a good national investment. It does not follow that such a scholar need seek to find his life-work in pure research, but he gets the opportunity of showing if he has abilities as an investigator; he also gets a training in research methods, and learns to run alone and get over difficulties by himself. In the last twenty years I have had seven or eight 1851 Exhibition research scholars working in my laboratory, and although their scholarship year or years has been occupied with pure research they have nearly all gone subsequently into positions in factories or works in which they had the opportunity of climbing up into good positions. These positions they would never have obtained but for the training they received in pure scientific research. Then, in the next place, as regards industrial or technical research, I agree with Mr. Swinburne and with Sir William Tilden and Professor Armstrong that it must be left to the technical manufacturers to settle. I therefore very much regret the unavoidable absence of Sir Robert Hadfield from the discussion, as in him we have one who speaks on this matter with authority, and if he had been able to be present he would no doubt have greatly extended the brief but interesting remarks he has made in his letter to me. With respect to the system of industrial fellowship inaugurated by Professor Robert Kennedy Duncan, to which I briefly alluded, I am not personally in favour of converting university laboratories into places for conducting too much commercial work; nevertheless, I have found it a great benefit to third-year students who have gone through the course work to take part in tests or researches made under commercial conditions. The chief business of the colleges should be to teach principles, but at the same time to give instruction or opportunities for learning how to apply them. As regards invention, I think we are also in agreement that the chief benefit the State can confer on scientific inventors is to let them alone. Beyond certain modifications in patent law which, as Mr. Swinburne says, speaking in the light of his great experience, should be settled largely by patentees and inventors, what is mainly required is that the politicians shall abstain from premature and unwise legislation. The manner in which certain scientific industries, such as electric lighting and traction and, as many think, telephony, have been handicapped, retarded, and injured by meddlesome and hasty legislation, is a story only too familiar to electrical engineers. But I hardly think that the time has yet arrived for the creation of a Ministry of Science. It would be a disaster of the first magnitude to have scientific research or its organisation in any way included in the atmosphere of party politics. It is difficult to see how any such post could be created and yet remain free and untouched by the struggles involved in political life. That very originality in scientific work which characterises our nation, which the Chairman has emphasized, is, I believe, a direct consequence of the intellectual and moral freedom we have enjoyed. Any bureaucratic control of science will imperil it. The German professor is in shackles to the State. Outside the limits of his own special work he has to do and say what the State tells him or he is a black-marked man. Hence I view with great trepidation proposals for the organisation of science which are based on the creation of Government control of details, and have urged here the organisation of science solely by scientific men. Professor Armstrong has said that my views do not appeal to him, though I am not quite sure what is the precise point on which he differs from me. At any rate I agree with him that the public school education must be reformed. In my opinion it is not merely a question of giving more time to science in schools and less to classics so much as elevating the whole tone of the teaching and quickening more an interest in intellectual things. The main absorbing interest in public schools hitherto has been the games. The intellectual life is relegated to a second place. After all the Government and the press merely reflect the thoughts of the people, and as long as the great mass of the nation think more of sport, games, fashion, amusement and politics than of the phenomena and structure of the world in which they live, science will be neglected by them. But, as Sir William Tilden said, we have received a horrible shaking up and are in a better frame of mind for it. One thing is perfectly certain: we have, as a nation, to set to work to make and manufacture scores or hundreds of things we have previously bought from Germany and Austria, and that will compel national attention to scientific matters hitherto ignored. Let me, in conclusion, thank the Chairman for his kind remarks, and the Secretary and Council for the privilege I have enjoyed of starting this interesting discussion."

It is to be hoped that Dr. Fleming's highly important subject will be widely considered and discussed, and I should like heartily to endorse his view that the organisation of scientific research is one of those matters that should be undertaken by scientific men themselves. In our country, unfortunately, the general public—including the average politician and Civil servant—are not much interested in science and have but little knowledge of it. It is altogether unsuitable, therefore, that the organisation of science should be left in their hands. If better attention were paid to scientific training at our public schools and universities this objection would be far less marked. One good result of the war will surely be to improve our defective training in science;

and I sincerely trust that the combined laboratory and workshop training will come into more general force for the preparation of young engineers, etc., more or less on the sandwich system that Dr. Fleming advocates. The present war being so largely one of science and invention, the future of the inventor is a matter of considerable importance. Up to the present time a large proportion of the things invented emanate from so-called professional inventors—the sort of man such as I once heard of as having the word "Inventor" written in large letters after his name on his visiting card, and even on his handbag! Unfortunately, it is found that the man whose sole purpose in life it is to invent—and to invent as speedily as possible—has very frequently had no practical experience or knowledge of the particular industry concerned in the invention; indeed, his inventions are far too general for that to be possible. Moreover, more often than not he has little knowledge of what has already been tried, and possibly patented, in the same field or with the same object in view. On the other hand, those possessing this knowledge, and through engagement in practical work being in the best position to invent, are liable to get too much into a groove as to the way of achieving desired objects. Unfortunately, too, it has to be added that our masters of industry do not, perhaps, encourage scientific and inventive research as much as they might well do or as much as they do in other countries more naturally interested up to the present time in scientific matters. The war should thereby have the effect of inducing within us a little more scientific enterprise, so that men of high scientific training and real inventive ability may be given the best opportunity of producing something really useful from our works for the benefit of those immediately concerned as well as for the nation as a whole. Meanwhile, the Scientific Intelligence and Information Bureau that Dr. Fleming speaks of would, I think, serve as a highly useful preliminary if brought into being with as little delay as possible; and I cannot help thinking that the Government would even now recognise the desirability of subsidising such an organisation if there was sufficient evidence of support from the right quarter. An institution of this kind ought further to render us independent of foreign-made goods both now and in the future.

CHARLES BRIGHT.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

FEBRUARY 23.—MISS H. B. HANSON, M.D., B.S., D.P.H., "Serbia as seen by a Red Cross Worker." SIR FRANCIS CHARLES GORE, K.C.B., Hon. Treasurer of the Serbian Relief Fund, will preside.

MARCH 1.—CHARLES DELCHEVALERIE, "Maeterlinck, Verhaeren et les Lettres belges."

MARCH 8.—CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare." DR. R. T. GLAZEBROOK, C.B., F.R.S., Director of the National Physical Laboratory, will preside.

MARCH 15.—EDWARD PERCY STEBBING, F.L.S., F.R.G.S., Head of the Department of Forestry, University of Edinburgh, "Forestry and the War."

MARCH 22.—REV. P. H. DITCHFIELD, "The England of Shakespeare."

MARCH 29.—

APRIL 5.—ARTHUR S. JENNINGS, "Painting by Dipping, Spraying, and other Mechanical Means."

MAY 3.—PROFESSOR W. B. BOTTOMLEY, M.A., F.C.S., "Bacterised Peat."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

APRIL 6.—PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

APRIL 27.—JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

MAY 18.—SARDAR DALJIT SINGH, C.S.I., "The Sikhs."

COLONIAL SECTION.

FEBRUARY 28 (Monday, at 4.30 p.m.).—PERCY HURD, "Next Steps in Empire Partnership."

APRIL 11 (Tuesday, at 4.30 p.m.).—SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

MAY 2 (Tuesday, at 4.30 p.m.).

Dates to be hereafter announced:—

R. W. SETON-WATSON, D.Litt., "The Balkan Problem."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

VICTOR HORTA, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

PROFESSOR T. G. MASARYK, "The Slavonic Peoples."

G. P. BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

Cantor Lectures.

Monday afternoons, at 4.30 p.m. :—

J. Erskine - Murray, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

Fothergill Lectures.

Monday afternoons, at 4.30 p.m. :—

Rev. Dr. Herbert West, D.D., A.R.I.B.A. (author of "Gothic Architecture in England and France"), "National and Historic Buildings in the War Zone: their Beauty and their Ruin." Three Lectures.

Syllabus.

Lecture III.—February 21.—*French Mediæval Sculpture.* Christian art that of a new-born society rising amidst a dying civilisation—Provençal sculpture, Arles, etc., decadent—Burgundian, full of life and imagination; but Classical influence traceable all through (Vezelay, Autun, Auxerre)—XIIth Century (Avallon, Bourges, N. and S. doors, Chartres, W. front). Elongation of statues, architectural not ignorant—Individual types, elaborate detail. The sculpture scheme of a XIIIth Century cathedral (Laon, Notre Dame, Amiens, Reims). The Judgment door (Autun, Notre Dame, Amiens, Rampillon, Reims, St. Maclou)—The Virgin's door—Local Saints and legends (St. John Baptist, Rouen; St. Stephen, St. Théophile, Paris; St. Thomas, Semur; St. Nicaise, Reims)—The Arts, Virtues and Vices—The Months and Daily Life (Paris, Amiens, Rouen)—Statuary (St. Stephen, Sens—The Virgin, Paris—Chartres, N. and S. porches)—Reims, W. portals—Figures of Christ (Chartres, Amiens, Reims, Troyes, Solesmes).

The lectures will be illustrated by lantern-slides.

Edward A. Reeves, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

MEETINGS FOR THE ENSUING WEEK.

Monday, February 21...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Fothergill Lecture.) Rev. G. H. West, "National and Historic Buildings in the War Zone: their Beauty and their Ruin." (Lecture III.)

Farmers' Club, at the Surveyors' Institution, 12, Great George-street, S.W., 4 p.m. Mr. C. Adeane, "Agriculture in the Devastated Districts of France and Belgium."

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Hon. W. P. Reeves, "The Balkan States." (Lecture III.)

Surveyors' Institution, 12, Great George-street, S.W., 8 p.m.

Geographical Society, Burlington-gardens, W., 8.30 p.m. Mr. A. P. Maudslay, "The Valley of Mexico."

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. A. H. T. Clarke, "The Fulfilment of Prophecy."

East India Association, Caxton Hall, Westminster, S.W., 4.15 p.m. Sir F. S. P. Lely, "A Forgotten Page in Indian History."

Tuesday, February 22...Illuminating Engineering Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Discussion on "Some Future Possibilities in the Design of Instruments for measuring Illumination (with special reference to Photometers depending on Physical and Chemical Methods)."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "Nerve Tone and Posture." (Lecture VI.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. C. C. James, "The Main Drainage of Cairo."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Rev. H. N. Hutchinson, Exhibition of drawings of Extinct Animals. 2. Mr. R. I. Pocock, Exhibition to illustrate the structure of the Tympanic Bulla in Hyænas. 3. Mr. C. T. Regan, Lantern exhibition of the nest of a Fighting Fish and the climbing habits of a Catfish. 4. Mr. B. F. Cummings, "Studies on the Anoplura and Mallophaga, being a Report upon a Collection from the Society's Gardens." (Part I.) 5. Dr. P. Chalmers Mitchell, "Further Observations on the Intestinal Tract of Mammals."

Electrical Engineers, Institution of (Local Section), 17, Albert-square, Manchester, 7.30 p.m. Mr. E. V. Paunell, "Continuous Current Railway Motors."

Wednesday, February 23...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Miss H. B. Hanson, M.D., "Serbia as seen by a Red Cross Worker."

Geological Society, Burlington House, W., 8 p.m. Mr. H. Dewey, "On the Origin of some River-Gorges in Cornwall and Devon."

Electrical Engineers, Institution of (Local Section), The University, Birmingham, 7 p.m. Dr. C. Chree, "Terrestrial Magnetism."

Thursday, February 24...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Child Study Society, at the Royal Sanitary Institute, 90, Buckingham Palace-road, S.W., 6 p.m. Mr. C. Burt, "Psychological Problems arising out of the War."

China and Japan Societies (Joint Meeting), Caxton Hall, Westminster, S.W., 3.30 p.m. Mr. Shinji Ishii, "The Island of Formosa and its Primitive Inhabitants."

Royal Institution, Albemarle-street, W., 3 p.m. Sir Frank Dyson, "Measurement of the Brightness of the Stars. Lecture III.—The Milky Way and the Magellanic Clouds."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m.

Friday, February 25...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor Sir A. Quiller-Couch, "The Commerce of Thought."

Engineers and Shipbuilders, North-East Coast Institution of, Newcastle-on-Tyne, 7.30 p.m.

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Professor W. G. S. Adams, "The Agricultural Resources of the Empire."

University of London, Bedford College, York Gate, Regent's Park, N.W., 5 p.m. Mr. A. D. Lindsay, "The International Crisis: the State and Society."

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Saturday, February 26...Royal Institution, Albemarle-street, W., 3 p.m. Hon. J. W. Fortescue, "Eminent Generals of the last Great War. Lecture II.—Sir John Moore."

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FRIDAY, FEBRUARY 25, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, MARCH 1st, 4.30 p.m. (Ordinary Meeting.) CHARLES DELCHEVALERIE, "Maeterlinck, Verhaeren et les Lettres belges" (in French). GEORGE GRANVILLE LEVESON-GOWER will preside.

Further particulars of the Society's meetings will be found at the end of this number.

INDIAN SECTION.

Thursday afternoon, February 17th, at 4.30 p.m.; LIEUT.-COLONEL SIR DAVID W. K. BARR, K.C.S.I., in the chair. A paper on "The Saints of Pandharpur: the Dawn of the Maratha Power," was read by Mr. C. A. KINCAID, C.V.O., I.C.S., author of "Deccan Nursery Tales," "The Indian Heroes," etc..

The paper and discussion will be published in a subsequent number of the *Journal.*

FOTHERGILL LECTURE.

On Monday afternoon, February 21st, the REV. DR. HERBERT WEST, D.D., A.R.I.B.A., author of "Gothic Architecture in England and France," delivered the third and final lecture of his course on "National and Historic Buildings in the War Zone: their Beauty and their Ruin."

On the motion of the CHAIRMAN, a vote of thanks was accorded to the Rev. Dr. Herbert West for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

ELEVENTH ORDINARY MEETING.

Wednesday, February 23rd, 1916; SIR FRANCIS CHARLES GORE, K.C.B., Hon. Treasurer to the Serbian Relief Fund, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Jeejeebhoy, Merwanjee D. M., 78, Apollo-street, Fort, Bombay, India.

Mukerji, B. K., Lashkar, Gwalior, India.

Oliphant, Professor Samuel Grant, A.M., Ph.D., Grove City College, Grove City, Pennsylvania, U.S.A.

The following candidates were balloted for and duly elected Fellows of the Society:—

Anderson, Frank Bartow, The Bank of California, San Francisco, California, U.S.A.

Dhari, Alakh, Oudh Commercial Bank, Limited, Fyzabad, India.

Farman, John, "Kirkholme," 16, St. James'-avenue, Beckenham, Kent.

Lall, P. C., Purnea City, Behar, India.

THE CHAIRMAN, in introducing the author, said that Miss Hanson was an assistant medical officer of the London County Council. At the beginning of the war she went with Mrs. Stobart to Antwerp, and was there during a great part of the siege. In March last she went out to Serbia, where she remained for five months in two hospitals in that country. She was then recalled by the London County Council to take up her duties in London. It was her experiences and adventures during her stay in Serbia that she gave in the paper.

The paper read was—

SERBIA AS SEEN BY A RED CROSS WORKER.

By MISS H. B. HANSON, M.D., B.S., D.P.H.

My time in Serbia unfortunately came to an end last August, owing to my being summoned home by the London County Council, so that I missed all the recent fighting and did not share in the adventurous trek which so many members of the various units took through Montenegro and Albania.

I had altogether six months in the country. From the beginning of the war I had worked with Mrs. Stobart's unit first in Antwerp, where we went through the bombardment, and then at Cherbourg. In February, 1915, as the number

of wounded in the latter town began getting fewer, Mrs. Stobart and many of the unit decided to come on to Serbia. They went across to England to collect stores while I came straight through *viâ* Italy and Greece, and, owing to delay in obtaining Government transport, they did not reach Serbia till the end of April, whereas I arrived in the beginning of March. I spent the two intervening months working in the Scotch Mission in Kragujevatz. This was the first of four units sent out by the Scotch federation of Women's Suffrage societies, which same body, having collected now some £80,000 besides numerous stores, has equipped also two women's hospitals for France. In every case the doctors of the unit were women, and so were nearly all the remainder of the staff. In Kragujevatz, for instance, the treasurer and a mechanic alone were men.

This unit had arrived in Kragujevatz at the beginning of the year, and had had a very uphill time. Fighting had not taken place since November, but during that month the Austrians had approached close to Kragujevatz, and the place had consequently been evacuated. For some time after their arrival, therefore, it was impossible to obtain any household utensils, and until their own stores were unpacked they had even some difficulty with food. They could not at once make their own feeding arrangements, as the stove they had brought out was so badly packed that it fell to pieces. Unpacking was done in the courtyard, and, as soon after their arrival heavy snow fell, the unit were engaged all one day grubbing for bits of stove in the snow. Even after being put together it always refused to cook a roast. So for the first few days they snatched a hasty breakfast of hot water and biscuit standing round a table, and for their midday meal they resorted to the one hotel in the place that had kept open. Unfortunately the hotel was not able to keep up to time in its arrangements, so that it sometimes occurred that the first batch of sisters who came off duty had to return to hospital to relieve the others before they had succeeded in getting any dinner at all themselves. There remained for some time shortage of various articles of food in the town, so that occasionally on buying cakes one found they had been made without sugar, and on one occasion, when a consignment of sugar had come up from Salonica, a crowd of some 300 persons gathered round the grocer's shop. At another time, too, salt ran out, and we were offered a keg of butter in exchange for a sixpenny bar of salt.

There was always a plentiful supply of meat, milk and eggs. At first there was only obtainable a rather coarse brown bread, and we were completely without butter for about two months, for Serbian butter we did not eat for fear of infection, and our own supplies had been mislaid at Malta. A similar disaster befell our tea. Sir Thomas Lipton, on one of his visits, kindly promised to supply this deficiency, and great disgust was felt when week after week went by and no tea arrived. At last, however, it was discovered that the precious chest had been by mistake taken by the orderlies into the matron's room to serve as a dressing-table. As regards meat there was more than enough, but there was a certain sameness about it. Pig formed our staple diet. From time to time it was varied by lamb, chickens, or turkeys, and it would, perhaps, have been varied more often had it not been for the fact that the animals for consumption generally came up alive, and after, for instance, a little kid had been made a plaything of for several days, or a woolly lamb had wandered round with blue ribbon and a bell, it went against our hearts to slay and eat them. It is, however, remarkable in how many ways pig can be cooked, and it was disguised all the more readily as the Serbians (and we employed a very good Serbian woman cook) do not joint their meat in an English manner. Pig stew, pig hash, pig joint, pig chop, and pig soup were served daily, and it was frequently the case that it was not till one was half through one's meal that a certain familiarity of flavour made one realise that one was once again consuming pork. At breakfast pig was also eaten under the courtesy title of bacon. One real drawback in the earlier part of the year was a lack of fresh vegetables. Still, there was an endless supply of prunes, and after eating these as a vegetable we quite contentedly ate them again with rice or custard as pudding. We had also, in default again of our own stores, nothing but eternal Serbian prune jam; altogether there was at times rather a sameness about the diet which led one of our numbers to comment on the brilliancy of our cook, who first, like any common or garden person, divided the week into seven days, and then carefully provided exactly the same menu for each day.

The house in which the Scotch unit was established was a very large roomy one that had at one time belonged to the Crown Prince. It was not, however, very suitable for a unit of forty-odd people, as it consisted of a number of big rooms which had to be used as dormitories for

eight or nine people each, nor was there any small room which we could portion off as a bathroom. Eventually we erected one with walls made of old bits of wood in the courtyard, and with an apple-tree bough for roof, the smaller branches of which acted as pegs, but in the earlier part of the year, with snow on the ground, this would have been useless.

On arriving in the town the Scotch unit had taken over a surgical hospital of some 200 beds, and at first their work was very arduous, as the Serbians had been unable to cope with the tremendous number of patients, and not only was the hospital (an old school), in common with all others, very overcrowded, but the wounds of the men were in a very septic condition. After a few weeks work, however, things began to arrange themselves satisfactorily. The convalescent patients had been drafted out, the hospital had been reduced to a state of order and comfort, so that, as one of the members of the Royal Army Medical Corps said, "You might as well be at home as be here," and a second commodious house had been assigned to the unit as a dwelling-place, when suddenly typhus, that had been left behind as a legacy by the retreating Austrian army, began spreading like wildfire over the country. Even at Salonica the moment one entered the train one realised that something unusual was afoot. The carriages were so strongly impregnated with formalin that one had to rush to the window and throw it up before one could breathe. Arrived on Serbian territory, we found the nature of the disinfectant changed, but it was even more in evidence. At the bigger stations in came a man with a keg of disinfectant on his back, which he proceeded to squirt impartially over one's compartment, one's baggage and oneself. At other stations, small boys would be found selling camphor or naphthaline, rather than food or papers, and indeed the people who came in and out of the carriage smelt strongly of these two things, and would drop pieces out of their pockets, skirts or bags as they moved. At that time, too, the Serbians could not afford oil to light their carriages, and a rather shabby appearance was consequently given to them by the splashes of grease that were strewn all over window, rack, cushions, and floor, from the candles that the passengers travelled with.

When we arrived in Kragujevatz itself, we found almost a plague-stricken city. The Serbians hang out a black flag from the house where a death has occurred, and thus in a very graphic manner the ravages of typhus were displayed. It was nothing to meet several funerals in a short walk, and since the Scotch dwelling-house was opposite the Cathedral, we used to hear the bells tolling nearly all day. No longer were funeral services allowed to be held in the Cathedral for fear of infection; but the bell tolled as the procession swept by.

If the large number of wounded had proved too great for the Serbians to handle, it can be imagined what the condition of affairs was like when the number of patients in the army was tripled by the incursions of typhus. Besides which it must be remembered that many medical men contracted the disease, while the activities of the ordinary population were crippled in a like manner. All the available buildings in Kragujevatz were laid under toll to provide room for the sick and wounded—schools, colleges, large houses, "gast-houses" (a sort of small restaurant), and even stables and cowsheds. One of these cowsheds, when cemented and properly fitted up by the "Wounded Allies," made a delightful hospital; and before its transformation its troughs had served for orderlies to sleep in. In their treatment of Austrian prisoners—the *fons et origo* of all the trouble—the Serbians never showed any less concern than for their own men. If the one suffered hardships owing to lack of space, attention and medical appliances, so did the other. I could never find any difference made between them; in fact, among our patients one was at first almost unaware which was Austrian and which was Serbian, but of the two the latter naturally succumbed more easily and a separate burying ground had soon to be set apart for them. Here it was impossible to dig separate graves; shallow pits were made, and the heavy rains of the spring and the heat of the summer made the cemetery at one time a very unpleasant place to visit. Despite this, a little wooden cross was erected with the name of the deceased, and after a few weeks a veritable forest of these covered the hillside. Just as they were unable to dig separate graves, so they were unable to provide separate coffins for the prisoners, and a number of bodies were placed together in a cart to be removed to the cemetery. The carts were hastily put together, and sometimes even between the crevices could be seen portions of human limbs.

Coming up from Salonica, one of the Scotch sisters, in spending a day at Nish, had been taken over a Serbian hospital. The director showed her all his arrangements, but displayed with especial pride and complacency a batch of

coffins in the corner. Of these he had been at first short; hence his delight at the large quantities now in stock; but it was not a reassuring spectacle for a new arrival in the country.

The shortness of space to place the patients in was rivalled by the shortness of the beds to lay them on. Many men slept on the floor. In some cases three shared two beds, or two one. The beds themselves were of the roughest make, and consisted generally of three planks on wooden trestles, with a straw mattress. These beds were particularly unsuitable for typhus patients, as during their delirium they frequently kicked the planks apart, and bed and patient together came clattering to the floor. There was also a great dearth of covering for the men. In one case, a patient had been two or three months in a Serbian hospital, and when he came into ours we found that he had lain so long curled up for warmth that for some days it was impossible for him to straighten out. Even means of transit were inadequate. On one occasion seven patients arrived at the hospital huddled together in an ox waggon, one of whom was already violently delirious. Other necessaries were lacking too; at one time, we ourselves, owing to a month's delay of baggage at Malta, were reduced for a few days to one thermometer for the whole hospital, and that the private property of one of the sisters. In Kragujevatz we were fortunate in having a fairly good supply of firing, though in exceptionally cold weather, when snow was on the ground, and when in consequence more than usual had been used during the day-time, we found sometimes at night that we had only enough wood for one fire, or at most a couple, in the whole hospital.

As regards food, there was a plentiful supply. The coarse brown bread was the staple food, and of this the men were very fond. They were allowed a certain ration every day, and in the surgical hospital sometimes sold what they did not want to visitors, outside the windows—in the early days after evacuation the people were glad to get it. Another frequent food was hard-boiled eggs, and these two articles lent themselves well to the men's custom of keeping their eatables under their pillows. Stews and soups, milk and rice pudding could not be satisfactorily disposed of thus, though on one occasion, after a feast day and a visit from friends, one patient was found with a whole roast sucking-pig under his pillow. This dainty he was to gnaw at intervals. On another occasion, in another hospital where I was working, we were surprised to find that one man always produced for cooking a fresh egg every day. This particular hospital was surrounded by a garden, and after a while we discovered that the man had enticed a hen into his bed.

In the earlier part of the year, when the patients consisted almost entirely of wounded men, and not of people suffering from typhus or other severe diseases, the attention they received from doctors and orderlies was not so strikingly inadequate; between English and Serbian medicine there is not much to choose. But of nursing as known in England there was, as in many other European countries, a complete absence; and since, as anyone with the most elementary knowledge of illness is aware, the nurse is always the better half of the doctor, the sufferings of the men when desperately ill and unable to help themselves can be more easily imagined than described.

Typhus is a disease that runs through fairly regular stages, and as—when the Scotch unit took over a second hospital—we cleared out gradually ward by ward of mixed diseases to put in typhus alone (sometimes as many as thirty-five patients a day, the full ward complement), we got a very good picture of the course it ran. The terrible mortality, in places 80 per cent., that occurred in February, owing to the hugeness of the epidemic and the consequent inability of the country to deal with it, fell with quite a moderate amount of nursing and care to about 10 per cent. For the first few days the patients for the most part did not seem acutely ill, but on about the fifth day the pulse would begin to cause anxiety, and while for some hours it would appear good, a chief characteristic was that suddenly it would almost vanish. At about the ninth or tenth day, in the large majority of cases, delirium set in, and the procession by night going round the bare ward, an orderly carrying one little lantern, was a very weird sight. On all sides men were tossing in their beds and gibbering and chattering like monkeys. Then, after a few days, the delirium got less, and suddenly one morning one would go in to find the men sitting up as one entered and clamouring for food. They could not wait till one got round, but, pointing to their mouths, called out from the other end of the ward, demanding soup and wine and a double portion of bread and chicken. Fortunately in this disease, unlike typhoid, one was able to accede to their requests. In a few cases, and these seldom recovered, the acute active delirium subsided, not into consciousness and recovery, but into an inert and passive

form in which the patient muttered and moved his fingers incessantly. It was the similarity of this stage of the disease to the delirium of enteric fever that gave the latter its designation "typhoid." In badly-nursed, ill-nourished cases, various complications such as gangrene and subacute inflammations arose; but in our hospital we saw little of these things. It was a consolation to find that the members of the Scotch unit who suffered from typhus, said that it was a comparatively painless disease, and those that had tried both, further volunteered that it compared very favourably with typhoid. As doubtless you all know, typhus is conveyed by the bite of a small animal, named "pediculus"—if one could keep free from bites one kept free from typhus. For safety, the Serbians relied a good deal on ordinary disinfectants, and also on garments that did not permit the entry of anything noxious. Each hospital in Serbia has a "director," who sees to various technical points, such as discharge, etc., and in our case the director took his midday meal in hospital, together with the dispenser and one or two clerks. They were kind enough to give us a general invitation to join, and as our house was some twenty minutes off we sometimes went. The meal began with a very interesting ceremony; methylated spirit was poured into each plate, set fire to, and then fork, knife, spoon and bread were passed through the flame. We relied chiefly on costume for protection. We intended wearing one-piece batiste garments fastened up the front and round the neck, but as the batiste did not arrive we had to take the bottom part of the pyjamas from our stores and wear that. Over this came an overall, of various sorts and shapes, some white, some grey, some fastened behind and some in front. Riding boots came nearly to our knees; these we bound round with muslin sprinkled with camphor oil or naphthaline. Our necks and sleeves were tied with the same sort of bandage, and our heads enveloped in muslin similarly scented. I may say that altogether it has never fallen to my lot in any time or place to see such an appalling collection of human beings. Years hence, legends will probably arise in Serbia of monsters, hideous in shape and form, who appeared at the time of the Great War, who scourged the already decimated Serbians with a virulent plague of typhus, and who still further tormented their victims with strange drugs, obnoxious food, copious ablutions and blasts of fresh air. It is impossible to give any reliable statistics of deaths; notification of the disease and of death were unknown. Even as regards the Army I never succeeded in getting any reliable figures. Only those dealing with the medical profession can I at all vouch for; here the number of people who succumbed rose steadily from units to tens, and tens till it got beyond a hundred. Altogether practically one-fourth of the Serbian doctors died. In our own unit we also had our victims; eight members had the disease and three died, amongst them an orderly, Miss Neil Fraser, the well-known golfer. Five sisters contracted it, two of whom died; while two doctors had it and recovered. No one could have been more kind than the Serbs when these calamities occurred, nor shown more genuine sorrow. I arrived in Kragujevatz the day the first funeral had taken place, and I sat up part of my second night with Miss Fraser. Two days later I attended her funeral. The service was in Serbian and conducted according to the rites of the Eastern Church and with full military honours. A representative of the Crown Prince was present, and the Serbians, amongst others, sent beautiful wreaths. The service took place outside the military barracks; the sky was grey and snow was on the ground, but the priests, with their brilliant velvet robes embroidered in gold and silver, the candles, and, above all, the music, rendered it a most impressive ceremony. The priests came up in ordinary garments, black robes and black felt hats, and proceeded to change in the open. During the whole service in their left hand they held a lighted yellow taper which they protected from the wind with their hats. One of those officiating carried a censor, and from time to time censed the coffin and the congregation; but it was the music that made the deepest impression. The service was almost entirely choral. Sometimes one priest alone, sometimes all together, intoned, and then the choir, unsurpliced, broke in suddenly with the responses in a sort of deep Gregorian chant, very wonderful and effective. The whole thing was poignant to a degree—plangent, appealing, and almost weird; incomparable with anything I have ever heard before in solemnity, beauty, pathos, and even tragedy. The service lasted some three-quarters of an hour, and after it was over a procession formed to walk the mile and a half to the cemetery. First came six boys in red-and-gold surplices, the first carrying a white cross engraved with the name of the deceased, the rest bearing aloft large gilt stars adorned with multitudinous rays. Then came the clergy, the military band (the Crown Prince's, the best in Serbia, in grey

uniform), then a gold cross, then the hearse, then the military attachés, the unit (in their grey uniform), and behind several well-known townspeople and various friends. The mud was inches deep, and plunging along, behind the swaying hearse, to the accompaniment of the magnificent funeral march, was an experience never to be forgotten. I walked with a relative of the aide-de-camp of the Crown Prince, a charming girl who spoke broken English. She was terribly distressed by the fact that two deaths should have occurred, and kept on saying, amidst tears, how noble was the work the unit was doing; it was brave enough to risk one's life for one's own country, but for someone else's country it was wonderful. Another short service took place outside the cemetery and yet another inside, while at the end the English military attaché read a few English prayers over the grave.

Yet another funeral took place later from the Scotch unit, and after Mrs. Stobart had been out some weeks an epidemic of typhoid ran riot amongst us. Seventeen of our members contracted it, while three died. Amongst these latter, an irreparable loss both to her personal friends and to the world at large, was Mrs. Percy Dearmer. This illness was not considered so infectious as typhus, and we were allowed the use of the Cathedral for the funeral. Most graciously we were permitted to use the English Service in one instance, and the fact that an Anglican Service was being held in an Eastern church made a very unpretentious service an historic event. In Mrs. Dearmer's case the service was Eastern conducted in Serbian, and as the coffin was borne down the Cathedral steps an English-speaking Serb made a funeral oration, addressing the deceased and saying how she had lived *sans peur et sans reproche*, and died as bravely as any soldier. Emphasis was laid on these words by the fact that the authorities had sent up for her a hearse usually reserved for officers, on the top of which shone the upper half of a suit of armour, and they had sent also to burn beside her all the previous day a candle in a beautiful huge silver candlestick. The procession that followed her to the grave must have been nearly a quarter of a mile long.

It was the intention of the Serbians to gather together the bodies of the various members of the English units who had died in Serbia and place them in a mausoleum, the designing of which had already been begun by a well-known Serbian artist when the autumn fighting broke out.

When first the Stobart unit reached Kragujevatz, the Scotch unit was much infected with typhus, so hardly any of our unit were permitted to go to visit them. Later, when we were infected with typhoid and they were well most of their unit were not allowed near us, and the only interchange of courtesies for some months, therefore, seemed to be attending each other's funerals.

Great anxiety was felt throughout the country during the illness of Lady Paget, and prayers were continually said for her in all the churches; an equally striking, though more humble tribute was the way in which an old man, who had been paid weekly by one Scotch sister to look after the grave of another, asked, when the first sister went home, if he might continue to attend to it without reward until the day of his own death.

Other units suffered greatly from disease; typhus and typhoid both attacked several. Amongst Lady Paget's staff at Uskub, amongst other missions there, and amongst one of the Scotch missions which settled later in the north, several deaths occurred. One mission alone, situated at Vrnjatchka Banja—where most of the English units in the country were massed when taken captive—has for a whole year shown an absolutely clean bill of health as regards any serious complaints. That is the unit under Mr. Berry, the well-known "Royal Free" surgeon. In every way his was the most favourably situated mission in Serbia. Vrnjatchka Banja is itself a modern health resort, placed high up amongst exquisite mountain scenery, and his main hospital, "Terapia," was originally a sanatorium and boasted electric light, a water-supply, and baths too numerous to count.

Furthermore, nearer the town was a large villa which was used as a receiving house for patients, where they were watched for some days before finally being distributed to the various hospitals, so that disease could declare itself without giving rise to widespread infection, and finally a sulphur swimming-bath close at hand was utilised to bathe all the patients who were well enough before they entered the hospital. Mr. Berry also built a typhus barraque—a wooden shanty with tiled roof. This edifice, the pride of the mission, was the last word in sanitariness, picturesqueness and comfort. It cost £100, was erected in fourteen days, and accommodated forty people. However, in one villa, the "Mercur," before the unit arrived out, an interned Austrian woman had for some time been doing the best she could for a number of convalescent patients. This villa was handed

over to the Berry unit as far as surgical attention went; but the old lady still continued in charge and swept round the wards in a trailing velvet skirt, a sight to make one shudder. For some time she remained immune, and she hugely amused us one day by wondering how it was members of the English units became ill. Did we, she inquired, have our windows sufficiently open, or wash our hands before meals? Not long after, however, she caught the disease herself, and had to be nursed up at the typhus barraque.

Next a word or two as to our orderlies. These were chiefly Austrian prisoners, who on being trained did their work exceedingly well. The freedom accorded them was remarkable, and compares with nothing in this country. It was accounted for largely by the fact that many of them were Slav in race and sympathy, coming from just across the Save and Danube. There had been in the earlier Austrian invasions some terrible instances of "frightfulness," but in the later ones these did not take place, and there were various stories of wholesale desertion from the Austrian army. At Vrnjatchka Banja a man who undertook housemaid's duties on the strength of having been married fifteen years, was asked by a Serbian lady how he came to fight against his own race. "Well," he replied, "we fought for one day, but we gave ourselves up in the evening." On another occasion two Serbs saw four Austrians approaching, and feeling themselves outnumbered prepared to surrender. "For God's sake don't do that," cried the Austrians, "we have come to surrender to you." The Serbian villagers were in many cases very kind to the prisoners, distributing food amongst them, and it often happened that an Austrian was put in authority over Serbian patients of a higher martial grade than himself. The friendliness of the Austrian for the Serb, too, may be shown by the fact that never, as far as I know, did he abuse his liberty, and on such occasions as the Serbs cried out with the pain of their dressings, the orderlies would admonish them gravely with "You are no Serb." On one occasion a somewhat humorous incident occurred. We had a sentinel at the typhus hospital, and this man one midnight going for his meal left his gun lying in the hall. An Austrian orderly coming downstairs, clad in evening attire of cotton pyjamas and night socks, immediately seized upon it and strutted up and down the corridor with great glee. He gave it up immediately on the return of the sentry, but at least for some minutes the only armed person in a hospital containing one English sister and 200 sick men, was one of the enemy. I must here emphasize the pluck of the nurses, one of whom night after night remained alone on duty in this hospital at the end of a lonely road and twenty minutes' walk away from any English help.

At Vrnjatchka Banja the orderlies were selected by the two English missions from a number of prisoners drawn up at the roadside. The scene was much like a slave market, the difference being that the men from hungry, unkempt, disease-stricken beings, became in a short time very healthy specimens of humanity, instead of the other way about. They were treated like patients in the matter of washing and shaving, and on one occasion at Vrnjatchka Banja a strange contretemps occurred. They were conducted to the sulphur baths and their clothes removed, but by some mistake no fresh ones were supplied. In the late afternoon their non-appearance at the hospital occasioned some comment, and on a search being made the party was found at the bath-house, having been impregnated with sulphur fumes for some seven hours.

On another occasion a hitch was caused with patients at the bath-house. One or two showed unusual reluctance to go into the water, and it was put down to obstreporousness. It was suddenly discovered, however, that the baths not having been used for several days a thin layer of poisonous gas had collected on the top, and it was this to which the men were objecting. Austrians were not only used as helpers in the wards, but they also did the housework and waited at table. At one time the waiters at the Scotch unit presented a rather variegated appearance, as they wore the upper halves of the pyjamas whose lower portions we made use of in the typhus hospital. There were men of all sorts and types among them. Some were simple, like the one who said to a friend of mind speaking of the war, "You know it is not a bit what you would think; you might be killed any moment." He had evidently expected a simple punitive expedition, fraught with no danger. There were several men from London restaurants, "Carlton," "Savoy," etc., who spoke English perfectly. One of these was a waiter at an English club in Nish, and another was chef at one of the Scotch missions. One of the waiters at Lady Paget's was a distinguished Viennese professor, the man who saw after the "Scotch" washing was a lawyer, and the man who blacked our boots in camp was reputed to be a millionaire.

Not long after the arrival of the Scotch unit in Kragujevatz, an English Army Medical Corps commission came out, thirty strong. Their first work was to see to the cleaning up of the country, and for that purpose they introduced a number of very simple disinfectors. These consisted of barrels through which steam was passed. Other places, other manners, and I shall never forget the curious entertainment provided one afternoon at the Scotch hospital when the *élite* of the military and civilian world were invited to come and watch a test experiment as regards the effectiveness of the sterilisation. After some difficulty in our now clean hospital, one or two garments, not free from pellicular life, had been secured, and these, having been submitted to the steam test, were solemnly handed round to the guests to investigate whether the deed had really been done, or whether in the case of the pediculus, as in that of Mark Twain, "the report of my death had been greatly exaggerated." Full powers had been given to the head of the commission by both Serbian and English Governments, and the speed with which legislation was enacted was a lesson to this country. A modest bill would be taken by special courier to Nish to be made in half an hour into an Act of Parliament. In this way notification of typhus was obtained; for a month also traffic was stopped, a very necessary measure, for the soldiers travelling back and forth on leave had been steadily infecting the outlying districts. After this typhus work was finished, the commission ran a sanitary train, fitted up with sleeping accommodation for thestaff, baths, disinfectors, consulting-rooms, etc., and went north to inoculate the army against cholera. A still more numerous French commission, which came out later, inoculated the civil population against the same disease, and also against diphtheria and small-pox, and it was doubtless owing to all this work that cholera—that worst scourge of all, compared with which typhus and plague are simple megrims—did not make its appearance in Serbia.

Besides these two, a strong American sanitary commission came out and worked rather further south. There were also several admirable American medical units, and in addition to the ten or twelve British, Danish and Dutch workers also arrived in the spring. Altogether when Mrs. Stobart reached Serbia at the end of April the country presented a very different appearance from earlier in the year. Typhus was no longer a pestilence that walked in darkness, and the vast majority of those soldiers who were still not quite recovered from their wounds were thoroughly convalescent. Mrs. Stobart offered the services of the unit for either typhus or surgical work, and the authorities chose the latter, giving us for a site a piece of high common ground out of the town, beyond the military barracks, from whence all round one could see an encircling belt of hills. We were entirely a field hospital, and our equipment of some sixty tents we erected and got ready for our patients within a week. We had accommodation for 130 men, but only a few days elapsed before we realised that our unit of forty-nine could not possibly occupy itself with only that number of patients, and while meditating on this point Mrs. Stobart had the brilliant inspiration of starting a number of wayside dispensaries between Kragujevatz (the military headquarters) and Belgrade. The civilian population was entirely without help. It was riddled with infectious diseases, and, apart from the sadness of its own plight, its condition was of grave military import as there were at that time continual rumours of advance, and the army was liable to get infected as it went north. Accordingly a small tent was put up on the road behind the camp, and more were to be erected as soon as further equipment could be got out from home. Meantime, two of the doctors, with a view of long quiet spells for learning the language, offered indefinitely to sit down there in state, beside attending to their own wards. The first day no patients arrived, and the languages proceeded admirably; the second day twelve came, rather a surprising number; the third day there were over thirty. This was disconcerting and the language was not touched; the fourth day there were over fifty, and soon after the week was out the number registered 150. By this time the work was hastily re-arranged, for 150 patients in a small tent, with an almost tropical sun, and when all the business has to be done through an interpreter, means a full day's work for two people. The patients came from distances of even forty miles, walking or riding in bullock carts and leaving home often at midnight. We found we were striking virgin soil; typhus came up that, thanks to the new legislation, we could notify and send forcibly into the town, typhoid, a good deal of scarlet fever, some small-pox and a great deal of diphtheria. This last was of a most virulent type, and it was amazing that children so badly infected could walk such miles to come and see us without succumbing to heart failure. In addition, there were many septic injuries, for the

prevailing ideas of how to dress wounds were primitive. Sometimes coffee grounds, sometimes tobacco leaves, would be plastered on a scald or burn, and on one occasion a curious appearance of very black gangrene turned out to be due to the painting on of ink. We found much indigestion, especially among men, a fact which did not bear out the contention of one optimistic old peasant lady, who said that: "Ah! you have beautiful food, and we eat only bread and a few onions, but we can fill our stomachs with green apples and be none the worse, whereas you would suffer much pain." We had various other complaints to treat, and at least one baby was born in camp and duly christened "Stobart." The patients were supposed to bring their own bottles, and a curious assortment came up; wine and beer bottles belonging to the country, of course, but also chloroform drop bottles, babies' bottles, and bottles of eau-de-cologne, though where they obtained these it would be difficult to say. Altogether, in the first three months we saw 5,000 patients, and when at the end of July six other dispensaries came into being, the number increased rapdily, and at the time fighting began again, 16,000 had passed through our hands. We had not been working long, however, before we found that to pretend to treat the patients without a civil hospital at our backs would be a farce. For the men we obtained permission to use the soldiers' wards, and for the women we erected another tent. Our first woman patient was a young girl of fourteen, who had to have her leg amputated for gangrene after typhus. She made a rapid recovery, and became the friend of all the camp, hobbling round on crutches. She was also invaluable in the ward, as she knew where anything and everything was kept, and our many changes of sister, consequent on the illness of the staff, made this trait a very valuable asset. Of military work in the Stobart camp there is not much of interest to record, as most of our cases were so convalescent. The men were very kind to each other, and took a great interest in each other's operations. They were very plucky, and frequently when they were being dressed would tell one it did not hurt, and urge one to be more vigorous. They appeared to have little dislike of operations, and occasionally even threatening to do them themselves when we disagreed with their desire for incisions; but they did dislike anæsthetics. They often begged for operations without chloroform, and though on some occasions their objections broke down when the actual operation was in progress, on other occasions they went right through. One man who underwent a small operation under a rather inadequate local anæsthetic, could not sufficiently compliment the doctor on having done it, while a really touching case occurred up at Vrnjatchka Banja. Mr. Berry had to remove several pieces of dead bone from the inside of a man's jaw, a very painful process, as he explained. Yet the man persisted in refusing chloroform, saying he had been through the last war, and thought he could stand the suffering involved. This was evidently very severe, as he flushed up and tears came into his eyes; but each time Mr. Berry removed a piece of bone the man, as soon as he recovered enough to speak, patted him affectionately on the shoulder, and said "Dobra doctor," *i.e.*, "Good doctor."

The number of wounded was reported to be under 3,000 by August, and as the work of the units was getting very light many felt it was unfair to stay on in the country, especially as the Serbs were most generous to their guests. However, the authorities were most anxious we should stay, as they said there was bound to be fighting eventually. Up till October we had only one or two experiences of "recently wounded." On June 9th at 5 a.m., just as we were rising (we breakfasted at the early hour of six o'clock), we heard what was to some of us the familiar sound of loud explosions, and looking out of our tents we saw two German aeroplanes overhead. Our camp was in the direct line between Belgrade and the town with its arsenal, and a few yards only from the wireless station. The aeroplanes made for the town and dropped bombs there, first aiming at the arsenal, the Crown Prince's house, the Cathedral, etc., and then as they passed back they dropped any remainder near us, to show us we were not forgotten. Whether they aimed at us or not it was impossible to say; but since our Red Cross flag clung coyly to our pole the whole while, there is no reason why they should not have imagined us a military camp. A few minutes after the two first aeroplanes disappeared a third arrived, and this deposited one bomb quite close to camp, sprinkling the outside of some of our tents. We were hurrying down to collect fragments (we succeeded in piecing together nearly the whole of one bomb, time-piece, handle, etc.), when we saw a woman lying on the ground. This proved to be a poor villager, whose husband had already been taken prisoner and whose two sons were at the war, who had been going into Kragujevatz from a distant hamlet to shop. She was very severely

wounded, her right humerus was broken in several places, and the soft tissues pulped. A piece of shell had also penetrated the lung. We got her into the theatre in a few minutes, and did what we could for her, and while we were operating the Serbian director of the hospital came up and remarked on how bad she looked. We inquired as to the extent of damage caused by the raid. He replied that five people had been killed and eighteen wounded, a few beasts were reported decapitated in the market place; but no building of any importance had been damaged. The report of the raid in the German papers that one afterwards saw, gave, however, a lurid account of a burning arsenal and a town in flames. Later in the day the director again came up, and we asked for further particulars of injuries. He gave us the total of six dead and seventeen injured. We asked him who it was that had succumbed since the morning, and he replied, "Oh! I am counting your woman." We laughed and said our woman was doing exceedingly well. For a day or two she had a little pain and temperature, but was soon up and about and able to go home, the piece of shell still inside her chest. No one perhaps was more surprised than ourselves at her remarkable progress. In Antwerp the men had at least lain some hours in the trenches, and had jolted over long rough roads before they reached us, while at Cherbourg they had had two days by land and sea, with practically only a first-aid dressing, before they could be got into hospital; so that in each case some sepsis was present. Moreover, the soil in France and Belgium is much more highly cultivated and infected with more dangerous germs than that of Serbia, so that the men had not had a fair chance. But given an opportunity of attending to the patient within a few minutes of the infliction of the wound, then one finds that Nature makes light of shrapnel and shell, and sets about repairing even terrible injuries with amazing resource and energy.

We had two more raids before we had to evacuate Kragujevatz. In one case one of the aeroplanes was hit and fell, a long sheet of flame behind it. In the other, one shell fell close to our linen tent but did not explode, and the other fell on some barracks near. These were new buildings, destined for our winter headquarters, and we had already had patients in them; but fortunately they were empty at the time but for the storage of tents and marmalade. This latter the cook had remorselessly hidden away as our stores were not arriving properly from home, and she did not wish to be left without any delicacies at Christmas. It was now scattered in a sticky tinny mess all over the field, and we mourned what we had lost. On the occasions of these raids we had no anxiety as regards the patients, as there was always long enough warning to evacuate camp before we ourselves were bombarded. Either we had news that an enemy raid was expected, or since the aeroplanes always devoted their first bombs to the town, we had the necessary quarter of an hour in which to get our patients a few minutes up the road into safety. Our cavalcade was a delight to the eye. Derry and Tom's had presented us, by request, with two carts, and these, after being adapted for bullock traction had been decorating the end of our camping ground for some weeks. We had also a fleet of five or six motors, amongst others, a fine car presented by the Harvard students, labelled American Red Cross Humanity and Neutrality. The motors, as their nature is, at first refused to move, and the carts with their loads of men in brightly coloured dressing-gowns and pyjamas were well up the road long before the lorries could be got to work. The patients seemed to like their joy-rides, and the subsequent picnics up in the wood; in fact, they seemed to regard their whole time in camp as a great jest. They were very much at home strolling about our grounds, and Mrs. Stobart they called "Mother." The alteration in their looks as they got better was marvellous. On one occasion I made several attempts to locate an old man who had come into the Scotch hospital with a very severe thigh wound, whom I had not seen for some weeks. I asked several times in which ward he was, and though always told the same number I could never identify him. Eventually I found that the six weeks had changed a decrepit old man of sixty into a handsome youth of twenty-five, and he was simply unrecognisable. We had one man in camp who had come because he refused to stay in a Serbian hospital. He had originally been with the Scotch unit, but as he repeatedly refused the very simple but necessary treatment they advised, he had been removed to military headquarters. After a few days, however, he found he could not get on without English sisters to nurse him, and so he demanded to be transferred to us.

Patients who had been a long while in the Scotch hospital sometimes came up to us to finish their cure in our more airy establishment, and great was their joy when they recognised

their old sisters and doctors amongst the visitors. The day begins early in Serbia, and it was by no means always five o'clock before peasants taking cattle into market were to be found *peering* into our tents. Mrs. Stobart was generally on the spot before this hour; but history relates that even on one occasion she was caught "napping." Sunday was our field day, when streams of townspeople came up to inspect us. The camp was certainly on a beautiful spot, and at no time of day or night, whether in sun or in rain, did the surroundings fail to be exquisite. Yet we were in by no means the prettiest part of Serbia. Sometimes the camp itself looked entrancing. Under a brilliant moon the dead-white tents with the little ruddy lights gleaming inside made a perfect picture. Serbia is certainly very beautiful. Approaching it from Greece one finds, first, bold desolate country with huge grey boulders and crags. The villages are desolate and dirty; an appearance which is produced, it is reported, by the fact that the Turks, whose dominion over the country ceased only in the latter half of last century, did not suffer the Christian population to whitewash their houses. But even in the wildest parts appeared early in March the delicate pink blossom of the almond tree. Beyond Nish, the country became well wooded and well cultivated, and a little later in the year the land was a sea of fruit blossom; the vivid pink of the peach blossom especially beautified everything with which it came in contact. Sometimes this was a mass of yellow waters, for the spring rains were torrential. Against the ruthlessness of the floods the Serbians have protected their hay by placing the stacks amidst the branches of trees, so that it is not uncommon to see, reaching out of the floods, a slim brown trunk on which rests a conical heap of grass, with young green branches projecting from top and sides, like the holly on a Christmas pudding. The rains indeed and the climate generally were such that one resolved never to complain of the English climate again. If our weather consists of travellers' samples, theirs consists of bargain sale remnants. A day or two of snow occurs at frequent intervals in the winter, while in between fires are sometimes hardly necessary. The latitude is about that of Marseilles, so that the sun is fairly powerful, and as the country is surrounded by huge masses of land the difference between night and day temperature is considerable. Under canvas in May the heat seemed almost tropical, and we wondered how we should fare later on; but it never became unbearable, for in June and July there were terrific storms, lasting sometimes a whole night. First the thunder would roll over camp, then it would be deflected to the distant hills, complete part of a circle there, and return over camp again. Then once more it would depart, and one could watch the distant lightning, sheets of fire, or violet pink and golden forks. Rain would simply be tipped out of the sky at the same time, and huge gales would blow down our tents and break our poles. The worst wind storm we had, however, was fortunately unaccompanied by rain, and it occurred mercifully in the daylight. At a few moments' notice a tornado swept through the camp, overthrowing seventeen tents; amongst them, two where members of our own unit were lying desperately ill with typhoid. Had this been a usual night storm, accompanied by rain, one or two must inevitably have died; as it was, no very serious harm ensued. But at night the camp took on the appearance of an ancient herding ground, where the ghostly forms of prehistoric monsters, white, brown and grey, were seen squatting on their haunches or lying motionlessly at their ease.

It was on this unique occasion when the mess tent and the stores tents were blown down, when the kitchen fires were extinguished, when we were reduced to an evening meal of doubtful quantity and quality, eaten almost in darkness, in a shelter formed by branches of trees, that several Serbian visitors came up to see how we had fared. It was always a point of honour in camp to offer hospitality to visitors, and they were asked, as a matter of course, to remain to dinner. On their refusing, Mrs. Stobart asked in pained surprise, "But you don't consider us disorganised, do you?"

This frequent rain and ensuing mud led our camp costume to be of a highly heterogeneous order. Some of the unit frankly wore riding breeches and leggings; others wore skirts shortened to the knee, even the orthodox nurses were reduced to Wellingtons and overalls belted up round the waist, or men's shirts treated in the same way. In the hotter weather, too, their immaculate collars and high dresses gave way to garments very open at the neck, caps turned into huge panamas or pith helmets, while at other times sunbonnets, waterproof hats, simple kerchiefs or the orthodox black silk hats of the unit were worn. We were a motley crew and must have served to deepen in the mind of the Serb the extraordinary impression of English women already created by the typhus unit. But the camp mud never quite equalled

what we had seen in connection with the typhus hospital. That building lay some way out of the town, and we had to go backwards and forwards a good deal in the dark. Riding boots hardly kept us clean, and at the hospital gate stood a man, not with anything so ordinary as a brush to remove the mud, but with a simple bucket of water to wash us down. One day going along, I discovered a man in mid-air, walking high and dry in the middle of the road. Wondering if the miracle would be repeated in my case, I tried the experiment also, whereupon I found a series of bricks had been laid down on which, if one could keep one's balance, one could walk as on stepping-stones. Even in the town at the time when the snow on the hills was melting, broad streams ran down each side of the cobbled street, and one often had to walk yards before one could find a narrow enough place to cross. We had one entertaining experience as regards mud in a motor-car. Mr. Berry, with whom I was then staying, had to come over to Kragujevatz to do an operation, and as it took over a day to compass the forty-four miles by train he decided to risk coming by car. The first fifteen miles was accomplished easily, then about three o'clock we stuck and had to be dragged out by some peasants; the second time we needed four oxen to assist us, and the third time six oxen took an hour to extricate us with the engine working as well. It was then getting dark and we were twelve miles from Kragujevatz, and as the houses were liable to be infected there was nothing for it but to spend the night in the open. Fortunately, Mr. and Mrs. Berry had sleeping bags, so, buying a little hay, they lay out in the driest place in the middle of the road. Unluckily I had no bag, so I was ignominiously relegated to the interior of the car, while the driver slept in front. There was frost in the night, and by eight next morning when we reached Kragujevatz we were decidedly cold and hungry. These roads had stood the Serbians in very good stead during the last invasion; the Austrians had been unable to drag their heavy guns along, and had left behind in their retreat large stores of equipment. Nothing more impressed on the mind the greatness of the Serbian victory in 1914 than a visit to the Kragujevatz arsenal, where numbers of huge sheds were completely filled by Austrian military apparatus. In the summer the mud was replaced by dust. As one motored along, no trace of road was visible behind, only at intervals just a head of a horse or cow could be seen coming out of the swirling clouds.

These were, however, minor matters. The flowers in the woods in the spring were exquisite. In the summer we trod daily under foot in the camp a variety of most dainty blossoms, while of all the summer wild flowers, perhaps the masses of yellow iris that grew in the fields were the most striking. The Serbians did not, however, leave us only wild flowers to admire; they erected in front of each dwelling-tent a little plot of raised ground wherein roses and other things grew. Mrs. Stobart had a similar little vegetable garden at the back of her tent; it gave an appearance of permanency in our nomadic life, as each garden looked uncommonly like a grave ready for the owner to tumble into should need arise. The Serbians also erected for us several huge shelters, formed of branches of trees, supported on a wooden framework. These remained delightfully cool when canvas was almost unbearable, and were invaluable in wind storms when our tents were demolished. They were put up, I believe, at the very kind suggestion of the Crown Prince.

We were, indeed, treated with the greatest kindness and consideration all through. Unlike either France or Belgium, the authorities made all the foreign units an allowance of 3 dinars (3 francs) a day for food. Moreover, there was at Nish a building where hospitality was given to members of units passing through as long as they liked to claim it. In addition, they kept us supplied with fuel, and as in the winter stoves were burning in nearly all the rooms this item was considerable. They made also very generous terms with some women doctors who came out to work under the Government, promising several hundred pounds to their relatives in the event of their death. Moreover, no other ally, as far as I am aware, has presented Red Cross decorations before the end of the war, and a large number of State Orders have even been given to members of the medical units. In one place, Mladnovatz, a fountain was erected last autumn in honour of Dr. Inglis and her Scotch missions, and one point struck us most forcibly, and that was that although some of our drastic changes in sanitation, disinfection, and above all in the nursing care of the patients, might have raised in lesser minds annoyance at the unavoidable criticism of their methods that they involved, we never saw anything but the most gracious and ungrudging readiness to comply with our demands. They were obviously intensely delighted, too, when any members of the unit recovered from serious illness—the director of one of the typhus hospitals, for

instance, on one occasion threatening a dance in honour of the event.

The peasants were equally pleasant to deal with. They are often very childlike, and there is a certain naivéte in some of their ways. For instance, to the Berry Mission was given a rather early-Victorian equipage, driven by a Serb. He was clothed and especially booted by the Mission to render him watertight, and invariably, after this ceremony was completed, the driver found some urgent necessity for departure, when a more needy and unkempt brother took his place. They have very pretty manners. Even youths, at what is in England the awkward age, were infected with them. I remember one boy of fifteen who came up to see his father in hospital, gracefully bowing over the doctor's hand and kissing it, while he thanked her for the care she had bestowed. Their language is exceedingly picturesque. One day when I was at Nish, near a cemetery, a young woman was wailing for her husband, who had been killed in the war. She would wail for a short while, and then begin intoning a lament, couched somewhat in these terms: "Other women's husbands return to them at nightfall and make them glad. Why do you not come back to me? Why is it that you are so still? I can only see you singing coming home in the evening, rejoicing in your strength. Is it true that Death holds you and will not set you free? Even then, why will you not let me come to you? Why do you refuse me entry? Unbar the door, unbar the door, I say, and I will come down." The woman would then continue her wail, and then once again utter the above refrain. I found coming home through Russia a very similar beauty of language. The English residents in Petrograd support a hospital for Russian soldiers, and the wife of the Ambassador interests herself in their wives and children, and sends them presents. I saw several letters of thanks, one of which, perhaps the most striking, ran somewhat on these lines. "Dear Lady of Bounty," it began, and it went on to describe the happiness that the reception of the gifts had caused, and to ask for a photograph of the donor as the children wished to place it beside their eikons. Then it continued: "But I am only a poor peasant woman, and I cannot express myself as I should, for truly as far as the eye sees and the ear hears, so far does your bounty extend."

The Serbian language itself closely resembles Russian. It reveals the Serb as a very contented creature, as the word one mostly hears in conversation is the word "dobra"—good. The word for bad one never hears; they simply say "not good." The fact that the Austrian orderlies spoke both German and Serbian made it rather a temptation to rub up one's ancient German rather than learn a new language. But it was remarkable what satisfactory conversations the least intelligent of us could hold. If one knew the one word "dobra," for instance, one proceeded thus: One entered the ward and addressed the patient in an inquiring and sympathetic tone, asking "dobra"? To this he would answer "dobra, doctor, dobra." One would then respond genially "dobra, dobra," and a conversation pleasing to all parties terminated, after which one addressed oneself to the Austrian orderly. But very often the reply to one's first "dobra," was given in a long rambling speech. This enabled one to shine far more, because one listened with care and then repeated it again in a sympathetic tone, which sounded as if one had understood the whole. The worst part of the language was the writing. Some of the letters were the same as those of the English alphabet, but half of these meant something different, and to make confusion more confounded they even varied in meaning where they could from the Greek letters.

The people are very democratic. The aristocracy, they say, was killed off by the Turks some six or seven centuries ago, so that they are now a race of sturdy peasant proprietors. Some of the best officers have been farmers, and a local grocer may, for instance, become aide-de-camp to a general, and on one occasion an M.P. came to our wayside dispensary at Kragujevatz.

In the few years since the Turkish yoke was thrown off, they have accomplished many things. They have started education, and we were much struck on visiting the site for the new Royal summer resort with the order in which they had proceeded with their public buildings. School and hospital had been first finished then a beautiful marble church erected, and finally the King's palace was about to be begun when the war broke out.

As regards poverty, we were most of us pleasantly surprised, for, with the exception of the refugees, such sordid poverty as one sees in our own slums we never came across. Living as they do on their own soil, they have the bare necessaries of existence, though, as there is a total absence of accumulated wealth in the country, they have absolutely nothing to draw

upon in times of disaster; and if Belgian refugees are pitiful and needy, Serbian ones are a thousand-fold more so. The women do the weaving, and since now they have been (very successfully) tilling the ground while their husbands are at the war, they have had to forego their usual occupations, and this gives the people a rather out-at-elbows appearance. But, ample though our stocks of misfits and second-hand clothes were, we seldom had the face to offer our ugly garments in place of their beautiful ones. Better, in the summer anyway, a few picturesque rags than ill-fitting British respectability. The Serbian love of colour was a continual joy; even in the typhus hospital it brightened up the dreary wards. During fever the Serbian wraps round head and body damp towels. These are striped with bright blue, red or green, and the same colour would be repeated in brilliant buttons on the night gear. The women's skirts hang in two full flounces. The design is a kind of Scotch plaid, but of such a sort never seen on sea or land, vivid pink and green in colouring, and oblong in pattern rather than square. The men wear a brilliant cummerbund, tightly wound round their waists, their figure as a consequence being very much slighter than that of the women. Reflecting on the aspersions cast on women's tight attire some years since, one wondered whether the men's digestive troubles were also a consequence. The socks are also radiant, the plainest having wreaths of brilliant roses worked round the top. But the *pièce de résistance* for both sexes is a leather jerkin, decorated in front with leather appliqué work, each petal of a huge flower being formed of a different colour, yellow, crimson, blue, etc. Leather pockets of still other shades, wools and even bits of mirror complete the design, and the whole is lined with lamb's-wool. We were surprised sometimes to see these jerkins worn up to the dispensary, with a temperature of 90 degrees in the shade; but we presumed that to appear in one's best clothes was meant as a compliment. The trying part was that it was often impossible to buy the garments or rugs, etc., that one desired, as they were just heirlooms made at home and there was no open market for them. At Vrnjatchka Banja, however, one thoughtful priest had taken his fees in things of this kind, and had sold them in the old days to Austrian, and now to English visitors. The cottages of the peasants were simple, but they had almost always a little verandah, quaint chimneys, and were kept very clean. The higher authorities also lived a simple life; the chief military authority in Vrnjatchka Banja, with his wife, having just one little room in a villa, and taking all his meals out.

The postal arrangements, too, during war time anyway were primitive. One would go down to the post office to find the supply of stamps had run out, the rarer sorts being indeed at all times only obtainable in the bigger cities. Telegrams also frequently took a day to go a short distance of under fifty miles.

The Serbians are a very musical people, and they sing beautifully; do not hesitate to do so, indeed, during the hours of darkness if they are occupied out of doors. This latter trait is imitated by the animal creation in the country; in camp one heard all night long a medley of frogs and nightingales, cuckoos and cocks, the latter having no idea of waiting for the dawn.

Although the Serbians' dislike to open windows is profound, they stand surprising degrees of cold with scanty garments in the open air.

One of the most picturesque scenes I saw in the early spring was the admission, at evening time, of patients to the Scotch hospital. They would come in about six o'clock. It was twilight, and the groups of men were standing about the courtyard. On one side, half sheltered by a bough of apple-blossom, sat a clerk at a little table with a lamp busy taking down particulars. Behind him was the bath-house, but the men undressed almost completely in the open before going in, and the darkness of their skins made the whole scene look very Eastern. Just outside the bath-house were two barbers shaving, and in the foreground, their toilet completed, stood a number of pyjamad figures waiting for shoes or a helping hand to take them across to the hospital dressing-room. One of the most surprising things about the people was the mixture of patience and pugnacity. The latter quality I need not stay to urge, but the former is less well realised. Now this was the condition of affairs which obtained in Serbia last winter. In the little tea-houses, forty or fifty of the more convalescent men would lie from day to day in the charge of one or two orderlies, some of whom were Austrians. The patients themselves were of some half-dozen different nationalities, *i.e.*, Serbs together with their enemies. Their day clothes were removed—it was reported they might dress and leave if they had them—so they could not get up, and the doctor only visited to do dressings every other day. They had no money for smokes, and the price of playing cards was prohibitive—it rose at one time in Kragujevatz

to over a sovereign. The meals were neither frequent nor exciting, and the inner parts of the "gast" houses were often dark and uninviting; there was therefore nothing to do, to look at, to read, to talk about, nor even to think of. Yet despite the Western proclivities of "idle hands," only twice in the whole of my six months did I hear of any quarrelling that needed an authoritative reprimand. I consider it marvellous. Now a word or two as to their customs. Several of these are very picturesque. Early in May a day is set apart for welcoming in the spring. Before four o'clock parties begin to leave the town, to go out on foot, by bullock carts or by carriage, to some place selected for an early morning picnic. The authorities kindly invited members of our units. They provided not only a substantial breakfast of lamb, wine, coffee, etc., but musicians and dancers and the whole company took part in the Kola, the Serbian national dance.

Easter, too, was quite a festive occasion. Both Serbians and Austrians declined to do any unnecessary work, and thought some of the English not a little mad for continuing their labours at mortuaries or drains. Exquisite flowers were sent us, and decorated eggs. Wherever we went we were offered cake, wine, etc., and the Serbs still hold to the old form of Easter greeting, "Christ is risen," with the response "He is risen indeed." Not the least interesting are some of the funeral customs. Food is brought to the funeral service, and again to memorial services which are held later at intervals of some weeks, months and years. The food is partaken of by the friends and distributed to the poor, and was even given in some recent cases to the prisoners. There were tables and chairs in the railed-off graves in the town cemeteries; but the country cemeteries with their vividly-painted, odd-shaped stone obelisks and their torn discoloured flags were the most striking. Along the roadside, too, similar painted and engraved stones were raised to soldiers who had died (not necessarily in the same spot), and sometimes a crude figure of the soldier himself had been carved on the stone and then coloured.

As regards the position of the women, although there are a few doctors and dentists it cannot on the whole be called advanced. Even on ceremonious occasions, as one Serb put it in broken English, "the women do not sit on the table." This we found to be the case. The military authorities always kindly gave us a farewell dinner at the club when any member of the unit was going home, but none of their own womenfolk were ever present.

A number of Serbian women helped in the hospitals, but it was not considered the business of any to desire a place in the limelight of the firing line. Naturally all the British units coveted that most of all, and the Serbians, with their usual gracious desire to please, I fear, involved themselves several deep in their promises of priority. They perhaps hardly took us seriously at first, for I remember, the day after the air raid, the head of the medical department—having been struck by the fact that it had improved the tone and vigour of camp rather than otherwise—said to me, "I see you do really want to go to the front." Dr. Inglis also, the head of the Scotch units, said that she had been amused at the change of front on the part of the Serbians in giving excuses for her not to go north whenever a skirmish had taken place on the Danube. At first it was "No; there are shells being fired up there. You would not like it." Latterly the excuse became, "There really is nothing doing there. You would find it dull." It was to Dr. Inglis also that one Serbian remarked, "We of the progressive party are almost more grateful to you for showing what women can do, than we are for the help you have rendered to the Serbians."

One incident that occurred in the typhus hospital is worth recording. We often argued with the director the position of women in his own country and ours, and he did not always come off victor. Now on one occasion it chanced that the night sister, going round a convalescent ward, discovered to her horror that amongst forty-odd men patients there was one woman. It had happened in this wise. We had been talking for some days of opening a woman's ward, and one doctor in the town, having heard of this, sent a patient up prematurely. Not only so, but he had labelled her as too ill to wait and see the admitting doctor, so she had been carried straight in to one of the few empty beds. But naturally we could not allow this kind of thing, so we went with some urgency to see the director the first thing in the morning. "Ah," he said, with a twinkle in his eye, "you see we make no silly distinctions of sex in Serbia," whereby he got some of his own back again. The Serbians amused us too by making "no silly distinctions of sex" in camp. The nurse in charge of a ward was, of course, called "sestro," the Serbian for sister, and after we had been working for some months a clergyman joined us as orderly, who, since he

had done a good deal of V.A.D. work at home, was soon made head of a convalescent ward. He also was immediately dubbed "sestro."

The Serbians are no more sensible than ourselves in the matter of forcing a man's nationality on his wife when he marries her. Just as the custom here immensely has increased our alien difficulties, so there also in the case of suspected spies they were unable to proceed against Austrian women without the most conclusive evidence. In the case of one woman who came up to camp, the authorities could do no more than warn us that they were practically certain that she was a spy, for the contents of some telegrams she had been handling had mysteriously leaked out. But they could do nothing against her as her husband was a Serb. I was not a little amused the other day to notice that the same difficulties were troubling another of our Allies, the French, so much so that indeed they were even contemplating making it illegal to marry enemy aliens. Forbidding marriage is a large order even for war time, and it would seem such a much simpler thing to some of us to let the woman retain her own nationality.

As regards many of the Serbian laws in such matters as disposal of refuse, registration of dogs and cattle, training of midwives, sale of poisons, etc., they were admirable; though with two of them we came unwittingly into conflict. After some months we rearranged the sanitary system of the Scotch hospital, and we then required two bullocks daily to remove refuse, etc. Two came, with long Serbian names, and one of the doctors immediately rechristened them to "Huz" and "Buz." We learnt afterwards that this had caused much trouble, as to change the name of a registered Government animal requires a complicated process at law. On another occasion, the fact of the town's being feet deep in mud having made us oblivious of the fact that there was never any untidy litter about the streets such as we often see at home, one of the sisters, thinking they would not be noticed, threw a few tea leaves from a hospital window on to the road. But, alas! next morning a note came round to the doctor in charge, saying would she kindly see that this did not occur again, for if it did they would have to convene a special meeting to consider how to deal with the offender.

The day after I arrived in Kragujevatz, I went to see the medical director of the army, and apparently even in those days we were not quite certain of what part Greece was going to play, for Dr. Soltan asked him jokingly what would happen if the Greeks turned against us and we could not go home by Salonica. "Oh," he replied jestingly, "you will go home by the Serbian Sea." Italy was not then an ally, and as Serbia hoped to conquer all the Austrian territory in the peninsula, it seemed only a sensible thing to rename the Adriatic. In the main the prophecy has come true; it is, as you know, through Montenegro and Albania and across the Adriatic that those members of the various English units who have reached home without having first been taken prisoners have come.

It is a matter for infinite regret that when Serbia had never before been so well supplied with medical and surgical personnel, appliances and stores (they had enough in the country to last two years), that all should have been rendered practically useless owing to the tragic rapidity of the invasion. In the three weeks after fighting began, and before they evacuated Kragujevatz, the Stobart unit alone attended to 1,000 patients, but all to little avail—they had to be left to be taken prisoners. Along the route the march was terrible enough for healthy men and women, short as they so often were of food, even healthy youths could not stand it; the boys approaching military age, who were coming out of Serbia, were in many cases unable to survive the rigours of the journey, and simply fell by the wayside.

As an Englishwoman, there is one fact that seems to me to sum up the tragedy, the hope deferred and the pathos of the whole thing more than any other, and it is this. For the first few months that I was out in Serbia it was our constant expectation that the English troops from the Dardanelles would be brought up to help in an offensive movement, as soon as Constantinople had fallen. True this was only to be talked of below one's breath, but sundry little vademecums, in Serb and English, full of military terms fell into our hands, and we were unable to believe that the authorities had chosen this particular moment to educate the mind of the British Tommy in the Slav languages without some useful purpose to subserve. Well, we know that Constantinople did not fall, but all the same there came a time when Serb and English both spoke openly of the help that was daily, nay hourly, expected from the advance of our men, and so great was their faith that a member of our unit, who came by a cattle truck on the last Serbian train to reach Salonica, told me that all the villages she passed through,

from Nish downwards, were decorated in honour of the advance of the Allies.

[The paper was illustrated by a number of lantern-slides.]

MRS. J. GORDON described the journey of herself and husband and party on their retreat from Serbia. Her husband was put in charge of some Englishmen of military age, and told to get them out of the country as best he could, as he knew something not only of the country but of the language, and had worked out on the map a new route. They left Vrnjatchka Banja about five o'clock, and waited for a train until nearly midnight, when the train came in quite full, and they were told by the stationmaster they must come again to-morrow. However, they managed to get on the top of the train with their clothing and blankets, and arrived at Kraliévo at two o'clock next morning, having spent most of the journey in obeying the stationmaster's instructions to "duck when you come to the railway bridges." On arrival at the town, in order to find accommodation they entered an open door where there was a light and found themselves in the telegraph office, and were told to try somewhere else. Around the corner a waiting-room was found absolutely crowded with people, and ultimately the party returned to the telegraph office, and, in spite of protest, lay down to sleep. The same difficulty in finding accommodation was experienced by some French doctors and an English girl from the Stobart unit. During the next few days they lived in a tent and gradually collected the men who were to go with the party. The guns seemed to be getting nearer every day. Dr. Churchill managed to get ten carriages which were like greengrocers' carts, and which were used to carry food obtained from a Red Cross train. The rice was so full of fleas that they had to boil and eat rice and fleas together, the other food consisting of margarine, biscuits, and bully beef. At the café, after a long wait, it was necessary to take part in a stampede in order to get coffee and meat. Bread was scarce, and only obtained with great difficulty. After a three days' halt the party started off, alternately walking and driving. They camped at night in muddy lanes, lying on mackintosh sheets in the rain. On reaching Rashka, they found everybody of importance had arrived there, and bread was ten francs a loaf, and hard to obtain at that. Austrian prisoners were given a loaf for four men for three days. The party managed to obtain leave to go on to Novibazar, although everyone declared there was no such road as Mr. Gordon had worked out on the map. At Novibazar, on inquiry of some Albanians, they were told it was quite possible to get across the mountains, and for thirteen hours they were climbing up through the mud. Everywhere the party, which numbered thirteen, had all to sleep on one floor. They were sixteen days at first without taking off their clothes and walking from dawn to dusk, living on rice and curry. In an Albanian house they found a room containing fourteen people, and an old woman offered to share her bed with the two ladies of the party, a bed which appeared to have been slept on for many years without having been once cleaned. The house was so small that two of the men had to sleep on a shelf. During the night someone unluckily struck a match and discovered that the whole place was streaming with bugs. The ventilation being bad, someone opened the street door, towards which all the savage dogs outside immediately rushed; if they had got into the room they would have made short work of the party. Miss Brindley was a cheerful travelling companion, never tired, and always ready to do anything for anybody. A boat had been arranged for to take the party to Scutari, but the captain would not sail as he said he was waiting for mattresses, and some hours later it was found that a mistake had been made on the telephone, the word "mattress" and "stranger" being almost the same in the Serbian language. At last a little French boat was obtained, and the party set sail. In the distance was an English cruiser, and a short distance away an Italian torpedo boat, while quite close could be seen the periscope of a submarine, so it was considered by the sailors that they were being well looked after, but on arrival in Brindisi they were told that the submarine was an Austrian one. The whole journey took five weeks, all walking.

On the proposition of the CHAIRMAN, a hearty vote of thanks was accorded to Miss Hanson for her paper, and the meeting then terminated.

THE CLOSING OF MUSEUMS.

Deputations from the Museums Association, the National Art Collections Fund, and the Imperial Arts League, with representatives of several other influential bodies, were received by the Prime Minister on Thursday, February 10th, and a summary of the proceedings appeared in the *Times* of February 11th. The deputations succeeded in obtaining the concessions that the zoological portion of the British Museum (Natural History) and the manuscript room at the British Museum should remain open, and elicited from Mr. Asquith confirmation of the statement that the Government had decided not to close either the Victoria and Albert Museum or the National Gallery.

But the Prime Minister stated with regard to provincial museums and art galleries that each community must decide for itself; the example of the Government need not necessarily be followed. The Museums Association suggest that in the event of a proposition being made to close any local museum it should be pointed out that the Retrenchment Committee's proposals have aroused a storm of public indignation, and that the Government has not considered it advisable to adopt by any means the whole of their recommendations. In provincial towns, too, there is

usually only one institution of the kind, and to close that one would mean an end to all the facilities a museum and art gallery affords. In London, however, there are many, and the closing of a few institutions, inadvisable as it seems, does not mean so complete a deprivation.

The opinion was authoritatively expressed after the interview, and has been emphasized since, that every effort should be made to carry the case of the British Museum to the House of Commons, and the Association suggests that each curator should at once organise an influentially signed letter to the member or members for his district, asking him to press for the exclusion of this great institution from the closing order.

IRON DEPOSITS OF BRAZIL.

Although geographically nearly as large as the United States and in many places highly mineralised, Brazil is almost unexploited as a mining proposition. The mining laws of the country have recently been remodelled in a manner that provides a decided step toward modernisation and practicable applicability; but this legislation will not overcome the lack of transportation facilities from the interior and the high cost of freights and of labour, which have hitherto been obstacles sufficient to keep the truly great mineral resources of the Republic almost untouched.

Of Brazil's iron ores, the hematites are in Minas Geraes, Matto Grosso, Goyaz, and Bahia; the magnetites (some titaniferous) in São Paulo, Parana, Santa Catharina, and Rio Grande do Sul. According to a report by the United States Consul-General at Rio de Janeiro, the most important deposits by far are those of the State of Minas Geraes. Through the central part of Minas Geraes extends the Serra de Espinhaço in a northerly-southerly direction. In this range of mountains are nearly all of the mineral deposits of the State. The great iron area seems really to be within a well-defined rectangle, fifty-six miles long by thirty-seven miles wide, with Burnier on the south side, Sabara on the north side, and Santa Barbara and Marianna on the east. In addition to the ores within this rectangle, scattered deposits extend northerly toward Diamentina, so that the high-grade iron-bearing formations probably occupy an area of some 2,200 square miles. If the lower-grade deposits are also considered, the area will be doubled in extent.

Three railways either tap or are projected to tap this district. The most important is the Government-owned line (the Central Railway), which enters the iron area near its south-western limit at Burnier, and extends northward to Sabara. It also has branches extending from Burnier to Marianna and from Sabara to Santa Barbara. From Rio de Janeiro, the nearest seaport, to Burnier is about 370 miles, and to this point the line is broad-gauge (5·25 ft.), while from Burnier to the other points the line is reduced in gauge to 3·28 ft. Another railway, the British-owned Leopoldina, does not enter this main rectangle, but is built to tap the deposits at Itabirra de Matto Dentro, north of the rectangle. Its seaport is also Rio de Janeiro, and the distance from Rio to Itabirra is about 390 miles. Still another railway, French-owned, is partially constructed to operate between the seaport Victoria and Itabirra de Matteo Dentro, a distance also of about 390 miles.

Classification of Ores—Probable Tonnage.

The ores may be classified as follows:—

(1) Bedded ores: (*a*) Very thick, bedded, massive hematite, including the dense, hard blue and the fine and coarse specular varieties and martite; beds are up to 300 ft. in width and a mile in length; (*b*) thin bedded laminated hematite, fine grained or crystalline, hard and soft; beds not so wide as (*a*), but of great length.

(2) Fragmental ores: (*a*) Canga, a conglomerate of hematite pebbles cemented together with limonite; (*b*) extensive beds of hematite "float" (rubble); (*c*) sand ore; "float" mixed with sands in river bottoms and elsewhere.

(3) Secondary ores, carbonates, etc.

The important ores commercially are the bedded hematites, both thick and thin, the Canga conglomerates, and the rubble ores.

In order to give some idea of the extent of the deposits, the Servico Geologico do Brazil selected nine of the largest and entirely exposed deposits and computed the cubic contents of each separately. These are of the bedded (highest grade) type, and are not assumed to have an extension below the surface of the surrounding country. On this basis they gave an estimated tonnage of 988,000,000. Dr. Orville Derby, the director of the Geological Service of Brazil, thinks this figure can conservatively be doubled, which tonnage about equals the total reserve of the Lake Superior ores to-day.

In addition to the above-estimated tonnage, which includes the highest grade ore only, there are known to exist millions of tons of the lower grade Canga and rubble ores. One deposit of rubble is estimated to contain 20,000,000 tons, while the Canga ores, running higher than 50 per cent. iron, would perhaps total 1,710,000,000 tons.

SUGAR-BEET GROWING IN EAST ANGLIA.

Sugar-beet growing is steadily on the increase in East Anglia, says the *Agricultural Gazette*. The sugar-beet factory at Cantley has this season received 20,000 tons of beet—a total which is 6,000 in excess of the previous year's consignments. These results are satisfactory in more ways than one, but more especially because they

tend to indicate that agriculturists, whose help is absolutely essential, are prepared to grow beet, without which it would be impossible to establish the sugar-beet industry in this country. Judging by the results just referred to, there is good ground for believing that it is only the beginning of a prosperous time for the manufacture of sugar in this country from home-grown beet. The officials of the factory, and more especially those who are constantly in touch with the farmers of the Eastern Counties, have sanguine hopes for the future. This is the fourth year of the factory, and in that time quite as good progress has been made as resulted on the ten years that were taken to establish the industry in Holland. The increase in the area of land put down to beet in Suffolk and Norfolk last year was highly encouraging; but if the acreage should increase in the next three years at the same ratio as it has done in the past three years, then the question will certainly arise of the necessity of erecting another factory, because then the capacity of the one at Cantley would not be equal to such a quantity of beet as would then be grown.

Twenty thousand tons of beet at the rate of 800 tons a day is now in the process of being converted into sugar at the Cantley factory; but this is only a third of the capacity of the factory, which, should occasion arise, will be able to deal with something like 60,000 tons in the season. Therefore, if the need should arise—and of this there are most hopeful signs—for putting up another factory, say, in Suffolk, it would probably be one capable of a larger output, with a capacity, as in the case with the biggest in Holland, up to 1,700 tons a day. There is one important factor which should contribute to the success of this new industry, and it is this—the sugar now being manufactured at Cantley is superior to anything made in Germany, from whence this country has derived such large supplies, amounting in value to as much as £13,000,000 annually in recent years.

THE FOREIGN TRADE OF ITALY IN 1914.

With the exception of beverages, spirits, and oils, all the classes into which the import trade of Italy is divided showed a marked decrease in 1914, especially as regards cereals, raw hides, raw silks, cocoons, coals, minerals, woollen goods, and raw cotton. The olive-oil crop of 1913 was a very poor one, and large consignments had to be purchased from Spain, Greece, and Tunis. The wine crop in 1913 was an abundant one against that of 1912. Exports consequently increased chiefly in connection with wine in casks sent to Switzerland, France, the United States, and Germany. Smaller consignments were forwarded to Brazil, the Argentine Republic, and Uruguay. The heavy fall in the exportation of vermouth is attributable to a decrease in the demand from the Argentine Republic and from Germany, two of Italy's good customers in respect of this article. Viewing the trade in colonial goods, there was a fall in the imports of all the items with the exception of manufactured tobacco, larger orders having been placed abroad for cigars and cigarettes. The decrease in the importation of sugar is due to the abundant home production, as the beetroot crop in 1913 was almost double that of the average yearly one. The 1914 crop has been, on the contrary, a very poor one, and that fact, together with the damage done to the sugar factories of Avezzano by an earthquake, called for a larger importation of sugar in 1915.

With regard to cotton, Italy had about 5,000,000 spindles in 1914. The previous year had been better than its predecessors as regards the exportation of cotton goods, but 1914 showed another and a most marked step backward. The importation of the raw material fell from 4,037,616 to 3,813,400 cwts. The United States and Turkey in Asia lost much ground, while the importation from British India increased, and that from Egypt remained almost unchanged.

The Italian silk industry, which is the most important in the country, suffered from the serious apprehension first of a fresh Balkan war and later on from the stringency of the monetary market. Finally the outbreak of the European war rendered the loss of silk factories heavier than could ever have been anticipated. Since the outbreak of war Italy has experienced the greatest difficulty in getting timber from Austria-Hungary, her chief supplier, and the importation of this commodity decreased very much. The Government has for some years past realised the necessity of encouraging reafforestation, with a view to rendering Italy independent of foreign countries for the supply of timber, the importation of which averages 1,250,000 tons per year. But for many years to come Italy will have to import large quantities of timber.

With regard to the details of importation of boots and shoes in the years 1912–14, in the latter year Germany sprang into the premier place previously occupied by England. Also in respect of machinery, Germany seems to have supplanted the United Kingdom's place for the supply of gas and air motors, while orders for spinning machinery continue to be shared by the two countries. A slight advance has been made by the United Kingdom in the exportation to Italy of agricultural machinery, but the United States and Germany continue to be the chief suppliers. The latter country has doubled the exportation of electric dynamos in Italy, while the United Kingdom and Austria-Hungary have lost much ground. The heavy fall in scientific instruments consigned to Italy was shared by Germany, the chief supplier, France, and, to a less extent, by the United Kingdom. The importation of coal into Italy has declined owing to the increased

rates of freight. An attempt was made to get coal from the United States, and the importation from the States was more than three times that of 1913. Nevertheless, the coal-supplying countries are headed by the United Kingdom, which occupies conspicuously the first place in the list. Nearly all the cereal crops in Italy in 1914 were smaller than in 1913, but the wheat yield was not only much below that of 1913, but was inferior to the average of the previous five years.

UTILISING SOUTHERN SCRUB PALMETTO IN THE UNITED STATES.

The scrub palmetto—of which there are several varieties, the most common being *Serenoa serrulata*—is a veritable pest in Florida, where vast areas are densely covered with the growth. Heretofore it has been put to little economic use; now, however, according to a report by a special agent of the United States Department of Commerce, a process has been perfected whereby mattings, binder twine, and the like are made from the fibre extracted from the leaves. This fibre takes dye readily, and its wearing qualities are said to surpass anything yet found in the way of floor coverings. Machines are set up in the palmetto fields and the leaves fed into them while green.

An aspect of the new industry that is of considerable value, apart from the manufacture of floor coverings, is that the twine made from the leaves is easily handled by grain binders, knots being tied without difficulty. For the manufacture of twine, however, the species known as the "cabbage" palm (*Sabal palmetto*) is employed, as it yields a fibre 3 to 5 ft. long.

The "cabbage" palm is native to the maritime parts of the United States from Florida to North Carolina. It attains a height of 40 to 50 ft., and has a crown of large palmate leaves, the blade 1 to 5 ft. in length and the footstalks long. The flowers are small, greenish, and in long racemes; the fruit black, about as long as a pea-pod, and inedible. The leaves are made into hats, mats, etc., and are also largely used for thatch. The terminal bud or "cabbage" is often eaten. The wood is extremely porous, but is preferred to every other kind of wood in North America for wharves, as it is very durable and not liable to be attacked by the teredo. The streets of Savannah and some other Southern cities are lined with these trees.

A second American species, the "saw" palmetto (*Serenoa serrulata*), occurs from South Carolina to Florida. It has a short stem and numerous clustered fan-shaped leaves, while its berries have certain medicinal properties. A still smaller species is the dwarf palmetto (*Sabal adamsonii*), a stemless plant which bears a cluster of leaves a foot or two long.

So far the scrub palmetto of Florida has been regarded as of little economic value. The leaves have been cut and shipped abroad (mainly to Germany), where they are turned into the "artificial palms" so extensively used for permanent decorative effects. Exports of palmetto leaves to Germany from the Florida customs district had an aggregate value of $11,650 (about £2,390) in the year ended June 30th, 1914. The shipments to other States of America, of course, are very much larger. The fibre has been used to some extent for mattress stuffing, and upon special order has been utilised in mixing plaster.

While the plant contains some tannic acid, the commercial production of tanning extract has so far not been attempted on a large scale because of the competition of other materials more easily and cheaply obtained. Bees evince a fondness for the flowers of the scrub palmetto, but the resulting honey is dark-coloured and has a peculiar taste.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

The Labour Supply.—For the time being the interest of producers and distributors of textile goods centres in the local tribunals, with whom it principally rests to settle the conditions under which business can be carried on. The decisions are eagerly canvassed as soon as they are made known, but the cumulative effect of the withdrawal of men from an already depleted labour supply remains to be seen from experience. The services of the pivot men are to an extent safeguarded, but no person has been engaged superfluously, and work can only become more difficult as time passes. The textile industries cannot escape the pinch exerted directly upon themselves, and upon all the surrounding industries upon whose services they rely. In the last resort all the difficulties of the hour, whether arising from fuel, dyestuff, transport or dear materials, are traceable to shortage of labour, and more shortening inevitably makes more trouble.

Trading with Germany.—In some quarters a vow to return to the use of German-made goods after the war is used as a threat to delinquent British manufacturers. The warning may be taken as the private equivalent to the adjurations coming from the public platform on the subject of education and enterprise. Both public and private discussions reveal a hearty repugnance against future dealings with the major enemy; but in public the tendency is to regard the matter simply as one of the purchase of German goods. The affair is one also of the sale of British goods, and those who have been accustomed to trade in the German market are still

at sea as to the prospect of recovering their debts and of finding their old customers solvent and disposed to trade. The attitude of the German Government is equally unknown, and in the circumstances it is not surprising to find these traders expecting little and looking rather to new markets than to the reopening of the old ones. The determination of a future trade policy is much under discussion and has taken a familiar controversial twist, but textile traders are as far off as ever from knowing how the exact situation will stand at some date hence.

Teaching the Foreigner.—Voices have been raised once more against the admission into English technical colleges of foreign students. Certainly in the day departments of some textile schools the number of foreigners has been disproportionate to that of the English-born. It may be doubted, however, whether it is in the schools that foreign students have acquired the information most directly to their purpose in imitating British goods. Manufacturers are wont to reckon mill training as the larger half of a technical education, and it is in the mill that technical science is applied to the purpose of producing saleable goods, whereas the schools are necessarily concerned more with the broad application of principles. At the instance usually of importunate customers foreign students have been admitted to mills and works, sometimes as premium-paying apprentices, and have made more or less good use of their time. It cannot be affirmed that any progress they have made has inured consistently to the disadvantage of British trade. English business is not all so insecurely held that it can be transferred promptly by the activities of observant youth, but doubtless the disposition to initiate strangers into our industrial ways has been decreased. The exchange arrangements by which young Continentals have been ushered into English works in return for a corresponding favour to an Englishman are not likely to grow more common than in the past.

The Heat-Value of Clothing.—Some experiments by Professors J. Joly and H. H. Dixon to determine the loss of heat from the body of an unclothed, as opposed to a clothed, swimmer prompt a reminder o similar experiments which might be made on and. There is no science of dress worth mention, and it may be remarkable that the facts about clothing have received as little exact study as would appear to be the case. There are points upon which precise knowledge would be welcome, even if no great results are to be apprehended. The writers upon hygiene contrive in general to exhibit a magnificent inappreciation of the differences between fabrics going by the same name, but differently constructed and manufactured from different qualities of raw material, so that many of their verdicts are crude ones. In connection with the loss of heat from the body there is room for experiments to demonstrate the comparative values of different sorts of wool. There are some empirical grounds for reckoning that clothes made of ultra-superfine wool are warmer in wear than clothing 25 per cent. heavier and made in a similar manner out of wool of the ordinary superfine quality. In turn, the latter are certainly more efficient containers of body-heat than the coarser varieties, and the scale of heat values would make at least an interesting complement to that of market values. The material employed for clothing is only one element in the larger question. As is seen in the cotton blanket, or in flannelette, a raw material not naturally favourable to the conservation of heat may be made to serve as a non-conductor by adapting the manner of its employment. The senses tell which clothing is the warmer, but there is scope for a more accurate measurement and for converting the data to practical use in textile work.

Odd Uses for Calico.—The *Journal of the Board of Agriculture* records the successful use of calico as an alternative to wood in making fowl-houses. A more useful calico than that of the ordinary drapery counter may be the heavily-sized grey sheetings and shirtings that are used for tenting in countries even as rainy as Abyssinia. Such goods are cheap in relation to their weight, and they are fairly waterproof. Lieut.-Colonel Falkner's calico poultry-houses may be likened to tents just as the shade cloths extensively used on tobacco plantations may be compared with curtains, and in any circumstances shades for plants are likely to call for more calico than tents for fowls. Light calicoes are used in some industrial premises as a ceiling to intercept the drip of condensed moisture. These odd employments for cotton fabrics have only their comparative strangeness in common with the use of cotton for shrouding refrigerated carcasses. Probably no use is unexampled, and certainly not that of cotton for shrouds, curtains and tents.

Potash from Wool.—In some other countries the carbonate of potash present in raw wool is recovered as a matter of course, the wool being steeped in plain water and the washings evaporated. In this country "de-suinting," as it is called, is done by few, and this for reasons connected with the kinds of wool principally in use. The content of potash salts varies with the soil of the pastures, and is on an average 5 per cent. in greasy Australian and Buenos Aires wools. In order to make the operation remunerative the liquor for evaporation must normally be of some such concentration as 7 per cent., and for want of encouraging returns the opportunity of recovery has been

disregarded. A process, however, has been worked out by a chemical engineer for securing the desired degree of concentration, avoiding heavy outlay in plant and dispensing with evaporators. Mr. E. V. Chambers provides for the washing of wool in the ordinary way in soap and alkali. The liquor from the machine passes into small settling tanks after flowing through a rotating disc screen for the interception of stray fibres. The liquid passes into a high-speed centrifugal separator, in which the sand and solids, the soapy water and the emulsified wool-grease are thrown into separate positions in the cage. The relatively clean soap solution is sent back to the washbowl until the requisite concentration has been reached and the potash can be recovered. The system presents economies over the older methods in any case, and the high prices of potash salts make any new source of supply exceptionally interesting at present.

Hand-made Goods.—A legal definition of the meaning attached to "homespun" may be expected shortly, and the evidence as to trade custom will presumably have final weight in determining what goods may be sold under this name without misdescription. The name conceivably implies slightly different things to different persons, denoting generally a roughly-made stuff. It need not be surprising to find the word homespun materially older than the factory era. Before there was any question of machine-spinning or power-loom, weaving yarn spun in one part of the country was sent to be woven in another, and in those times home-spun must have been read in its local rather than its purely domestic connotation. "Handspun" is more directly expressive of hand-spinning. "Handwoven" leaves the origin of the yarn open, and it is patent that some tweeds sold as hand-made or woven are, in fact, made with yarn spun by machine. The power-loom has no such advantage in output over the hand-loom as the mule has over the spinning-wheel. It can be added that the mechanism of weaving has no such impress either upon the individuality of the resultant cloth. Whether hand-made yarn is in any respect better than machine-made is a moot point; it is, in any event, very much more expensive to produce. The question of superiority is not so much one of the means as of the material employed, and the degree of twisting. The external characteristics of hand-made tweeds owe perhaps as much to the absence of finish as to all other causes. Indeed, it is not too sure that there have not been "hand-made" goods which were in fact machine-made articles sold in a rawer state than the one to which they are normally advanced. As the several names are used to justify fancy prices, or sometimes to misdescribe shoddy goods, there is reason enough for arriving at a sound understanding of what the names imply.

OBITUARY.

VISCOUNT RIDLEY.—Viscount Ridley died on the 14th inst. at Newcastle-on-Tyne. He was born in 1874, and was educated at Eton and Balliol. After leaving Oxford he became private secretary to his father, Sir Matthew White Ridley at the Home Office, and he subsequently acted as aide-de-camp to Lord Aberdeen when he was Governor-General of Canada. He became a member of the House of Commons in 1900, when he was elected for Staleybridge, and acted as private secretary to Mr. A. T. Ritchie and to Mr. Austen Chamberlain. He succeeded his father in 1904. He was an active advocate of Tariff Reform, and took a leading part in local politics. A man of many interests, he would doubtless, had his life not been prematurely cut short, have risen to an important position in the service of the State.

He became a member of the Society in 1902, and served as a Member of Council for a year in 1904–5. He took occasional part in some of the discussions, and presided at the meeting in February, 1905, when Mr. C. F. Just read a paper on "The Manufactures of the Dominion of Canada."

HON. SIR JOHN WINTHROP HACKETT, K.C.M.G., M.A., LL.D.—The death on the 19th inst. at Perth, West Australia, of the Hon. Sir John Winthrop Hackett is announced. He was born at Lordello, County Dublin, in 1848, and was educated at Trinity College, Dublin. In 1874 he was called to the Irish Bar, and after his emigration to Australia he joined the Bars of New South Wales, Western Australia, and Victoria. He was editor and proprietor of the *West Australian* and *Western Mail* newspapers. He took a very active part in political and other affairs in Australia, and occupied many important public positions in his own colony—amongst them he was the first Chancellor of Perth University. He was knighted in 1911, and became a K.C.M.G. in 1913.

He joined the Society in 1906, and in the following year he read a paper here on "Social and Economic Conditions in Australia," for which he was awarded the Society's silver medal.

GENERAL NOTES.

PASTELS BY JOHN RUSSELL, R.A.—A small collection of pastels by John Russell, R.A. (born 1745, died 1806), the most famous English painter in that medium, has been arranged in Room 81 at the Victoria and Albert Museum. It includes two family portraits lent by Mr. C. B. Pattrick, four works lent by a descendant of the artist, and eight examples belonging to the Museum. In his youth Russell obtained three premiums from the Society of Arts: in 1758, five guineas for a pen-and-ink sketch of "An Hussar, after Worledge," in the class of young persons under fourteen who "had

never been taught"; in 1759 four guineas, for a drawing "A Belisarius, after Strange," in the class under fourteen; and in 1760 three guineas in the class under sixteen, for a drawing the subject of which is not recorded.

Sulphate of Ammonia.—Lord Selborne, in a leaflet issued by the Board of Agriculture and Fisheries, calls the attention of farmers to the fact that the decision to suspend the issue of licences for the export of sulphate of ammonia was based on the assumption that the home demand for this fertiliser would be substantially increased. Unless therefore farmers at once increase their demand, the result will be that stocks will accumulate and the output will be curtailed. In view of the importance of using every effort to stimulate the production of maximum crops during the war, in the interests both of agriculture and of the nation generally, Lord Selborne appeals to farmers to avail themselves without delay of the present opportunity to procure supplies of sulphate of ammonia for spring use.

Potash from Feldspar and Distillery Waste.—Several new methods of increasing the supply of potash have recently been brought to the attention of the United States Bureau of Foreign and Domestic Commerce. One of the most promising of these efforts to find a substitute for German fertilisers is a patent lately taken out by a Canadian for a method of using the potash in ordinary feldspar. The process is a simple one, consisting of heating the feldspar with limestone and iron oxide at a temperature of about 2,200° F., which produces a partly-fused mass that is easily decomposed by a weak acid. From this product the potash salts can readily be extracted for further purification. The inventor has been in consultation with Dr. Norton, the expert who has been studying the potash and dyestuffs situations for the Bureau of Foreign and Domestic Commerce, and it seems very possible that a greatly simplified method of transforming feldspar into fertiliser will soon be available. A practical "try-out" for another method of obtaining potash fertiliser will take place at a New Orleans distillery where molasses are used in large quantities. It is a fact, says the Bureau, that 106 tons of potash are wasted daily by the twenty-five or more distilleries in the United States that subject molasses to processes of fermentation. The New Orleans company is planning to instal the process of saving the potash in distillery waste recently brought to the attention of the public by the Bureau of Commerce. It should be possible, adds the Bureau, to make fertiliser from this otherwise worthless material at a price that will meet competition even after the war is over.

Concrete as a Protection from Rust.—In connection with the enlargement of the Victoria terminus of the London, Brighton, and South Coast Railway, a covering of fine concrete to all the overbridges in the station has been adopted. The ironwork is thus protected from corrosion from the weather, and from the steam emitted by the locomotives passing under it. At the Cortland Street ferry end of the Pennsylvania and New York City Railway, according to Mr. Henry Adams, President of the Concrete Institute, the whole of the steelwork has been covered with a thin coating of sand and cement, sprayed on it by means of a "cement gun" after carefully cleaning the surfaces of the steelwork. A test piece successfully resisted the most severe trials. It was kept in moist salt air for three days, in salt water for three days, in a temperature of 5° below zero for forty-eight hours, and then allowed to thaw in a warm room; then it was placed on a boiler subjected to a heat of 110° for three days; then it was dropped 2 ft. on a wooden floor, again on a concrete one, and showed no signs of cracking.

Microstructural Changes in Annealed Bronze.—The properties of cast steel may be greatly improved as a result of refining the grain by proper annealing. The changes occurring in cast brasses and bronzes upon annealing are by many metalworkers regarded in the same light. A study has just been completed by the United States Bureau of Standards of the annealing of bronze, using the commercially important alloy zinc bronze (copper 88, tin 10, zinc 2) as a type. The results show that bronze is very different in its behaviour from steel, and shows no recrystallisation or grain refining, unless it has been previously cold worked as by rolling or hammering. Copies of this publication may be obtained upon application to the Bureau of Standards, Washington, D.C.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

March 1.—Charles Delchevalerie, "Maeterlinck, Verhaeren et les Lettres belges." George Granville Leveson-Gower will preside.

March 8.—Charles R. Darling, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare." Dr. R. T. Glazebrook, C.B., F.R.S., Director of the National Physical Laboratory, will preside.

March 15.—Edward Percy Stebbing, F.L.S., F.R.G.S., Head of the Department of Forestry, University of Edinburgh, "Forestry and the War."

March 22.—Rev. P. H. Ditchfield, "The England of Shakespeare."

March 29.—R. W. Seton-Watson, D.Litt., "Pan-German Aspirations in the Near East."

April 5.—Arthur S. Jennings, "Painting by Dipping, Spraying, and other Mechanical Means."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m. :—

APRIL 6.—PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India." THE RIGHT HON. LORD ISLINGTON, G.C.M.G., will preside.

APRIL 27.—JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

MAY 18.—SARDAR DALJIT SINGH, C.S.I., "The Sikhs."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 p.m. :—

APRIL 11.—SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

Dates to be hereafter announced :—

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

VICTOR HORTA, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

PROFESSOR T. G. MASARYK, "The Slavonic Peoples."

G. P. BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

PERCY HURD, "Next Steps in Empire Partnership."

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m. :—

EDWARD A. REEVES, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 28...Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Hon. W. P. Reeves, "The Balkan States." (Lecture IV.)

Medicine, Royal Society of, 1, Wimpole-street, W., 5.30 p.m. Discussion on "War Injuries to the Jaws and Face."

Actuaries, Institute of, Staple Inn Hall, Holborn, W.C., 5 p.m.

TUESDAY, FEBRUARY 29...Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. J. Russell, "The Plant and the Soil—Nature's Cycle." (Lecture I.)

WEDNESDAY, MARCH 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mons. C. Delchevalerie, "Maeterlinck, Verhaeren et les Lettres belges."

Civil Engineers of Ireland, Institution of, 35, Dawson-street, Dublin, 8 p.m.

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. E. J. Bevan and W. Bacon, "The Manufacture of English Chemical Filter Paper." 2. Mr. A. W. Knapp, "Pink Colour on the Surface of Margarine." 3. Mr. S. B. Phillips, "A Rapid Method for the Estimation of Fat in Powders." 4. Mr. C. E. Stacy, "A New Colour Reaction for Aloes."

Sanitary Engineers, Institute of, Caxton Hall, Westminster, S.W., 7 p.m. Lieutenant B. R. Hebblethwaite, "Sanitary Work at the Front with the Expeditionary Force."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Rev. A. du Bulay Hill, "A Saxon Church at East Bridgford, with Some Notes on Pre-Norman Remains in Nottinghamshire."

University of London, King's College, Strand, W.C., 5.15 p.m. Professor S. Askenazy, "The Spirit of Poland."

THURSDAY, MARCH 2...Royal Society, Burlington House, W., 4.30 p.m.

Linnean Society, Burlington House, W., 8 p.m. 1. Dr. Annie Porter, "Exhibit of *Giardia* (*Lamblia*) *intestinalis* from Cases of Diarrhœa in Soldiers, the Infections being Contracted in Flanders." 2. Dr. J. D. F. Gilchrist, "Larval and Post-Larval Stages of *Jasus lalandii*." 3. Mr. B. M. Griffiths, "The August Heleoplankton of some North Worcestershire Pools." 4. Dr. O. Stapf, "The Distribution of the Box-tree, *Buxus sempervirens*."

Child Study Society, at the Royal Sanitary Institute, 90, Buckingham Palace-road, S.W., 6 p.m. Mr. A. E. Hayes, "The Danish Child at School."

Chemical Society, Burlington House, W., 8.30 p.m. 1. Messrs. H. R. Procter and J. A. Wilson, "The Acid-gelatine Equilibrium." 2. Mr. W. Caldwell, "Chloro- and Bromotriethylphosphinoacetaldehyde."

Royal Institution, Albemarle-street, W., 5.30 p.m. Professor L. W. King, "Recent Excavations in Mesopotamia. Lecture I.—The Northern Capitals, Nineveh and Asshur."

Medicine, Royal Society of, 1, Wimpole-street, W., 5.30 p.m. Dr. Clippingdale, "The Thames Valley—Certain of its Natural and Medical Attributes."

FRIDAY, MARCH 3...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor S. P. Thompson, "Corona and other Forms of Electric Discharge."

Geologists' Association, University College, W.C., 7.30 p.m.

University of London, Bedford College, York Gate, Regent's Park, N.W., 5 p.m. Canon Hastings Rashdall, "The International Crisis: the Theory of the State."

Medicine, Royal Society of, 1, Wimpole-street, W., 8.30 p.m. 1. Captain G. Marshall, "The Choice of Anæsthetics at a Casualty Clearing Station." 2. Dr. Harold Low, "An Apparatus for the Intratracheal Insufflation of Ether." 3. Dr. F. E. Shipway, "An Apparatus for the Administration of Warm Anæsthetic Vapours."

SATURDAY, MARCH 4...Royal Institution, Albemarle-street, W., 3 p.m. Hon. J. W. Fortescue, "Eminent Generals of the last Great War. Lecture III.—Wellington's Divisional Commanders."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

NEXT WEEK.

WEDNESDAY, MARCH 8th, 4.30 p.m. (Ordinary Meeting.) CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare." RICHARD T. GLAZEBROOK, C.B., M.A., D.Sc., F.R.S., Director of the National Physical Laboratory, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, February 17th, 1916; LIEUT.-COLONEL SIR DAVID BARR, K.C.S.I., in the chair.

The paper read was—

THE SAINTS OF PANDHARPUR: THE DAWN OF THE MARATHA POWER.

By C. A. KINCAID, C.V.O., I.C.S.,
Author of "Deccan Nursery Tales," "The Indian Heroes," "The Tale of a Tulsi Plant," etc.

The subject of my paper is the early dawn of the Maratha power. I wish, however, to preface it by some explanatory remarks. In the course of it I have carefully abstained from laying down that any particular fact is legendary and not historical. The men whose names I shall mention are worshipped either as divine saints or as incarnations of various deities. To hazard publicly an opinion that any of their recorded miracles never occurred might possibly give great offence.

That you may better understand the subject of this paper, I would ask you for a moment to come back with me to the year A.D. 1192. At that time Delhi was the capital of Prithvi Raj, chief of the Chohan Rajputs; Kanauj was the capital of the Rathors. South of the Vindhya Mountains a new dynasty had just emerged. One Bhillama Yadhav, a Maratha chief of the same family as the rulers of Dhorasamudra in Mysore, had, after a series of battles, declared himself independent and had founded as his capital the town of Devgiri, now known as Daulatabad. In the Punjab a foreigner had established himself. Between the Afghan cities of Ghazni and Herat run the hills of Ghor. The wild tribes of that region had overpowered the successors of Mahmud the Ghaznivide, who more than sixty years before had raided India to sack Somnath; and, led by a great captain, Muizzadin, better known as Mahomed Ghori, they had consolidated into a powerful kingdom, Sind, the North-Western Punjab and Eastern Afghanistan. Mahomed Ghori had, in 1191, tried to push further eastwards into India; but he had been severely defeated by Prithvi Raj. The year A.D. 1192 was to see the Afghan's revenge. On the scene of his previous defeat he overthrew the Chohans, and on the banks of the Jumna he defeated the Rathors.

By these two victories Mahomed Ghori founded the Mussulman kingdom of Delhi, which was to last over 600 years, and in the course of his reign most of Northern India fell a prey to his arms. The country south of the Vindhyas was not immediately affected by the success of the Ghori Afghans. For 100 years afterwards the Yadhav dynasty not only endured but prospered. Thus when, in 1290, Jalaluddin Firoz Khilji became Emperor of Delhi, Ramdev Yadhav, the fifth in descent from Bhillama, had been ruling over Devgiri for nineteen years. For four years more he continued to rule without any mishap, when a palace squabble in Delhi struck down his prosperity. Jalaluddin's nephew Alauddin was married to the Emperor's daughter. The marriage was unhappy, and Alauddin feared that his wife would induce her father to kill or imprison her husband. He asked for and obtained leave to collect an army to attack

Chanderi. Then he passed beyond it into the Deccan, and without any warning raided Devgiri. The raid was a complete success. The Maratha chief offered hardly any resistance and gladly paid a huge ransom. With it and the prestige of victory Alauddin returned to Delhi, and not long afterwards murdered his uncle and became emperor in his stead. Once master of the Delhi throne, Alauddin reduced Devgiri to vassalage. His successor, Kutubuddin Mubarak, completely subdued it.

The extraordinary collapse of Devgiri was probably due to other causes than the superior physique or courage of the Mussulmans. The previous establishment of the Spaniards in the Caribbean Sea was of itself the main cause of the downfall of the Aztecs. The ferment in the mind of Montezuma more surely caused his ruin than the military skill of Cortez. In the same way the conquest of the great Rajput kingdoms of the North, and the intrusion of another religion—that of Islam—into India, upset all the previous conceptions of the Hindus. The Brahmans pronounced that the domination of the Mussulmans was foreordained to last for 30,000 years. And long before the Afghans came the Marathas had accepted them as their future conquerors. Nor did the conquest cease with the overthrow of the Yadhavs. For a moment it seemed likely that the whole Deccan would turn Mussulman. From this national calamity the Maratha race was saved by the Saints of Pandharpur.

The first of these saints was Dnyandev. Although it is impossible to fix exactly the dates of any of them, we may say with some certainty that Dnyandev was a contemporary of Alauddin and of Ramdev. The story of his birth, as told by Mahipati, is as follows. The sins of the world had so increased that Brahmadev and Shiva sought out Vishnu to consider the question. As a result of the interview Shiva took the form of Nivratti, Vishnu that of Dnyandev, and Brahmadev that of Sopana. Lastly Laxmi assumed human shape in their sister Muktabai. The method of the incarnation was as follows. The earthly father of the three brothers and their sister was one Vithoba, a Brahman from Apegaon. His wife was one Rakhmai, the daughter of a Brahman at Alandi, a small town on the Indryani, about twelve miles north of Poona. Vithoba and Rakhmai settled at Alandi, but the married pair, although happy, were childless. In a fit of melancholy, caused by the death of his parents, Vithoba went to Benares and became a *sanyasi*, or anchorite. This was a sin on his part, for no one who has a living wife and no children should take *sanyas*. Eventually his preceptor came to hear the true facts, which Vithoba had concealed, and made him return to Alandi and once again to live with his wife. This reunion led to the birth of Nivratti, Dnyandev, Sopana and Muktabai. The return, however, of Vithoba to the life of a householder, after he had taken a vow of asceticism, offended deeply the Brahmans of Alandi. They out-casted him. And when he wished to have his son Nivratti invested with the sacred thread they refused, unless he could get the Brahmans of Paithan, a holy place on the Godaveri, to give him a letter of purification. Nivratti with his two brothers and his sister went to Paithan, asked for the letter, and at first received a flat refusal. Then the Brahmans said that if Nivratti bowed to every cow, ass, hare or dog that he met, thinking the while of Brahmadev, they would relent in his favour. Lastly, hearing Dnyandev's name, they mocked him by transferring it to a buffalo that happened to pass. Dnyandev, however, was in no way disconcerted. He placed his hand on the buffalo's head. And to show that in the sight of God no earthly distinctions mattered, he made the buffalo recite the four Vedas without an error. This miracle was soon followed by another one. He called up the ancestors of his landlord to attend the *shradh* ceremony of the latter's father in place of the Brahmans who had refused his invitation owing to the presence of his four polluted lodgers. Convinced by these two miracles, the Paithan Brahmans gave the letter of purification to Nivratti, and he was duly invested with the sacred thread. To tell the miracles of Dnyandev and his brethren would take me many hours. I shall simply relate one more, which occurred at Alandi. A certain Changdev—really an incarnation of Indra—was a Brahman of extraordinary occult power and knowledge. The allotted term of his life was only 100 years. By an original device he managed to prolong it to 1,400 years. When his 100 years were on the point of closing he disengaged his soul from his body and hid it, leaving his corpse on the ground. When Yama, the god of death, came to take away Changdev's soul, he found only an empty corpse, and after a vain search for the soul had to leave on other business. Directly Yama left, Changdev's soul came out of its hiding, re-entered his body, and started on a fresh 100 years. When he had done this fourteen times he had acquired a vast amount of experience and wisdom, and

wished to try a fall with Dnyandev. Changdev did not declare open warfare. He affected to wish that Dnyandev should become his *guru*, or spiritual teacher. He wished to send him a letter to this effect, but as he could not bring himself to address Dnyandev as *tirtharup* (*i.e.*, father), he sent Dnyandev merely a blank sheet of paper. Nevertheless, Dnyandev grasped Changdev's meaning, and in reply sent him a letter of sixty-five verses. But the sense was too deep for Changdev. Unwilling to confess himself beaten, he mounted a tiger, took a snake in his hand for a whip and, followed by over one thousand pupils, he sailed through the sky until he met Dnyandev outside Alandi. Dnyandev, however, was in no way disturbed by the apparition. He mounted a wall and made it run alongside Changdev's tiger. Both man and beast were dumbfounded, and Changdev became a devout follower of Dnyandev. I may add that Changdev obtained no further extension of life. When his current one hundred years expired, Yama came again and this time carried off Changdev's soul in triumph.

The poet Namdev, to whom I shall again refer, has told in touching stanzas the death of Dnyandev. When he felt the approach of death, he asked that he might be buried at Pandharpur. But the god Krishna bade him choose Alandi as his burial place. There, amid a great company of gods and saints, Dnyandev entered alive a cave dug beneath an image of Nandi (Shiva's bull), and ordered it to be closed. A golden peepul tree grew out of his tomb. His bamboo staff took root and grew into a tree. And to-day Alandi is regarded by Marathas as only second in holiness to Pandharpur.

But let us return to our main theme. Why should Dnyandev be called a Saint of Pandharpur? Pandharpur is a very old shrine in the Sholapur district, on the banks of the Bhima. It appears to have once been a shrine of Shiva; but within historical times the worship of Shiva has been overshadowed by that of Vithal. According to Sir R. Bhandarkar, Vithal, or Vithu, is merely a Canarese corruption of Vishnu; and at Pandharpur Vithal is regarded as a synonym of Vishnu's incarnation Krishna. Now Dnyandev was a follower of Krishna; his books, the Dnyaneshwari and the Amritanubhav, glorify Krishna. By his talents and fame he made it the chief religious centre in the Deccan. Next, how did he save the Maratha race? To those who were drawn towards Islam he offered another and more warmly coloured faith. Instead of the austere prophet of Arabia, he bade men look to the wondrous child of Mathura; by holding out hopes of brighter things in a future life he enabled men better to bear their present troubles. At one time an out-caste himself, his renown as a saint proved to men of all castes that Krishna looked more to faith in him than to pure birth or sacrifice or ceremonial. Devotees of all, especially the lower, castes began to crowd to Pandharpur. One famous worshipper, Savata, was a *mali*, a gardener; Ranka was a *kumbhar*, or potter; Chokhamela was a *mhar*, one of the untouchable classes. Yet, according to Mahipati, he found such favour in the eyes of Vithal that one night, after the priests had mocked Chokhamela, Vithal's image descended from its shrine and, lifting Chokhamela from his bed, carried him inside the temple and placed him by its side. Nor did Pandharpur attract only Hindus. Kabir, a Mussulman weaver, was permitted to become one of Vithal's most ardent worshippers. Nor did her sex exclude Mirabai. Betrothed as a young girl in the usual Hindu way to a boy of her own caste and position, she fell in love with Krishna's image. And, resisting all and various persecutions, she became an ardent follower of the god, and eventually migrating to Dwarka composed there the first poems ever written in Guzarathi. But when caste ties are weakened, as Dnyandev's teaching weakened them, something else must take its place. Man, a gregarious animal, wishes to associate with other men on some common basis. The usual substitutes for caste are common religion and common language. And so it followed that all those who worshipped at Pandharpur, and could speak to each other in the language of Dnyandev, and could read his poetry, became drawn to each other. In this way the Maratha race became the Maratha nation.

I would now ask you once again to turn to political history. In 1347, about fifty years after Alauddin's first assault on Devgiri, Hasan Ganga revolted against the Delhi emperor, Mahomed Tughlak, and founded what is known as the Bahmani empire; and now for the first time since the conquest we hear of the Marathas. By the aid of the Maratha nobles the revolution succeeded. They were no longer the rough country bumpkins so easily routed by Alauddin. The poetry and metaphysics of Pandharpur had enlarged their minds; they had become capable of learning military science and of proving useful allies to a great soldier. This change in the Maratha nobles is reflected in the work of the Pandharpur poet Namdev. This famous

man deserves really a paper to himself; as it is, I can give him very little space. According to Mahipati, Namdev was an incarnation of Uddhav, the friend of Krishna. His parents, Damshet and Gonabai, were members of the Shimpi, or tailor caste, and lived at Pandharpur. They were childless, but in their old age Vithal took pity on them and granted them a son. He was not born in the usual way, but was found by Gonabai inside a shell that came floating down the Bhima River. Damshet and Gonabai accepted him gladly, and by means of another miracle Gonabai, although advanced in years and not his mother, was able to nurse him herself. Namdev always writes of himself as a contemporary of Dnyandev; but, as Sir R. Bhandarkar has pointed out, the difference between the Marathi of the two poets makes this impossible. According to Sir R. Bhandarkar, Namdev lived at the close of the fourteenth century. Taking this surmise as correct, Namdev lived some years after the Bahmani empire had been founded by the aid of the Maratha nobles. He neglected entirely his tailor's business to become an ardent psalmist of the god Vithal; but whereas Dnyandev bade his readers cast out from their minds all earthly affairs, a different tendency is to be found in Namdev's verses. He advises his followers not to make vows, fasts, or pilgrimages, or to practise austerities. They will find salvation in the remembrance of Hari (*i.e.*, Vithal). If they are so unfortunate as to have worldly duties, let them perform them; but they should, during the performance, remember god always. And here follows a delightful illustration. They should act exactly like an unfaithful wife. To the outside world she appears to be attending to her husband's comforts, but inwardly she never ceases to think of her absent lover.

At the close of the fifteenth century the Bahmani empire began to break up, and in its place arose the states of Bijapur, Ahmadnagar, Golconda, Berar and Bidar. These five states were always quarrelling; they were cut off from the Mussulman recruiting ground beyond the Himalayas. Thus the Marathas yearly obtained fresh opportunities of advancement, and by the sixteenth century we find Mores and Nimbalkars, Ghatges and Manes, Ghorpades and Daphles, holding high offices both in Ahmadnagar and Bijapur. Indeed, it is probable that within another 200 years the Mussulman Padshahs would automatically have disappeared in favour of Hindu kings had not certain events happened beyond the Vindhyas. In 1526 Babar, King of Ferghana, successfully invaded India, and founded what is known as the Moghul Empire. In 1556 his grandson Akbar became Emperor of Delhi; and he, his grandson Shah Jehan, and his great grandson Aurangzib, never ceased to covet the southern kingdoms as former provinces of the Delhi empire. The most accessible, and therefore the first victim, was Ahmadnagar, and by 1637 it had been completely annexed. It was clear that Bijapur would soon meet the same fate, and the Marathas, so far from realising their hopes of independence, seemed likely to become merely "a conscript appendage to a foreign power." Let us now see how this calamity affected the Saints of Pandharpur. In 1607 there was born at Dehu, a town fourteen miles to the north-east of Poona, one Tukaram More. He inherited a village shop, but he had no head for business. His thoughts, influenced by the sufferings of his country, turned to religion; he became bankrupt, and, leaving his wife to provide for their family as best she could, he turned for consolation to Vithoba. But the old Brahmanical opposition to saintship in inferior castes, crushed at Pandharpur, lingered at Dehu. Tukaram was forced to throw his poems into the Indryani, which passes by Dehu. Vithoba, however, befriended him, and the poems a few days later returned perfectly dry to the surface of the water. After this miracle Tukaram was hailed as a saint, and when he died at the age of forty-two or thereabouts, at Dehu, Vishnu sent his heavenly chariot to convey him to heaven. In Tukaram's works we find a distinct retreat from Namdev's position to that of the earliest saints. Nowhere have I seen any suggestion that man's duty lies in work. On the contrary, Tukaram repeats over and over again, "False is the world; Hari (*i.e.*, Vithoba) alone is real." At the same time he emphasizes the view that in the eyes of Vithoba caste has no meaning: "God does not feel ashamed to help anyone; he seeks to comfort people of all conditions."

But if the political situation made Tukaram despair, there were two men alive at this time who saw that out of it might arise freedom. The first was a Deshasth Brahman called Narayan; he was the son of a certain Suryajipant and his wife Rambai. From his earliest days the young Brahman devoted himself to the worship, not of Vithoba, but of Ramchandra the conqueror of Lanka, the seventh instead of the eighth incarnation of Vishnu. Nevertheless, Pandharpur can claim him as one of her saints,

for, according to his biographer, Narayan received a call to Pandharpur from Vithal himself. When he went there the god informed him that Rama and Vithal were one, and commanded him to visit Pandharpur at least once a year. This command Narayan did not fail to obey. The second was a lad of amazing talents, who was growing to manhood in Poona city. His father had been one of the foremost soldiers in the service of Ahmadnagar. He had tried in vain to save that kingdom, and after its fall had taken service with the king of Bijapur. The lad's mother was a descendant of the old Yadhav kings of Devgiri. His parents had quarrelled and the boy grew up under the care of his mother Jijabai and an old Brahman called Dadaji Kondev. No surroundings could have been more favourable to the growth of a daring man. The Brahman repeated to the boy the old Sanskrit tales of the Indian heroes, until the latter vowed that he would be as brave as Ramchandra and as knightly as Arjuna. At the same time Jijabai told her son legends of the glory of the old Hindu kings his ancestors, and urged him to restore at least some measure of their greatness. The boy grew into a man. He first seized the forts round Poona, and then successfully defied in turn the governments of Bijapur and Delhi. His name was Shivaji Bhosle, and he is immortal as the liberator of the Maratha nation. This, however, is not the place to write of Shivaji the conqueror. I wish to show his connection with the Saints of Pandharpur. From the first Shivaji was a deeply religious man. After his successful raid on Chandrarav More, Shivaji fortified Pratapgad. It was an anxious time, as Bijapur would certainly try to avenge their officer's death. Shivaji's thoughts turned to things spiritual. He sought a preceptor to instruct him more fully in religion. By this time the young Narayan had become a renowned saint. So fervently did he worship Ramchandra that men said that he was an incarnation of Maruti, the monkey god who helped the divine hero on his southern march. And Narayan himself took the name of *Ramdas*, or slave of Rama. Shivaji heard of him, and wished to make him his *guru* or spiritual teacher, and went to see him at Chaphal where he had built a temple to his favourite god. But Ramdas hid himself and Shivaji sought him everywhere in vain. At last Shivaji vowed that he would not touch food until he had seen the saint. Then Ramdas relented. He sent him a metrical letter exhorting him to restore the Hindu religion and to clear the country of its Mussulman oppressors. The next day Shivaji and Ramdas met. The king, delighted with the letter, was still more pleased with the saint. He would not, however, make Ramdas his *guru* without a test. He ordered him, so runs a story, to fetch a *ser* of tigress' milk. Such a task was nothing to Ramdas. He went at once into the forest, sought out a tigress with cubs, milked her, and brought back the milk to the king. From this time on Ramdas was the constant companion and spiritual guide of the king. His influence was wise and kindly. While he taught Shivaji the duties of kingship, and the divine task which lay before him of freeing his countrymen, he at the same time bade him not to be over stern, to speak no harsh words, not to cherish his anger, and not to act unjustly in any matter. And Shivaji's career shows this teaching. He gave no mercy to Afzul Khan the Bijapur general, but he treated his beaten army with the utmost consideration. Shivaji would have killed Aurangzib without scruple; but when Abaji Sondev captured, and sent as a present to the king, the beautiful daughter-in-law of Mulana Ahmad—the Mussulman governor of Kalyan—Shivaji sent her home again to her relations with all respect. In spite of his influence over Shivaji, Ramdas was wise enough not to seek to guide his campaigns. Unlike Peter the Hermit, Ramdas did not wish both to inspire and to lead a crusade. When Shivaji heard of the approach of Afzul Khan, he asked Ramdas' advice. The saint replied that he could not advise. Shivaji should pray for guidance to Bhavani, the goddess of Pratapgad. The saint knew that the king's fertile brain would, if left to itself, devise the proper measures. But when the king grew vain of his victories Ramdas did not hesitate to rebuke him. Once the king and the saint were watching the building of Samangad fort. Thousands of men were at work, all paid by the royal treasury. The king let fall some remark that showed his pride that he was the source of their livelihood. "That," replied Ramdas, "is but a small part of your great work." He then bade some workmen split open a boulder close by. In the centre was a cavity half filled with water, in the water was a frog. "O, king," said Ramdas, "who but you could have made a hole in the centre of the stone, placed a frog in it and provided it with water." The king was confused, asked the saint's forgiveness, and admitted that it was alike God who had kept alive the frog and God who cared for the needs of the workers at Samangad.

Now let us sum up the work of the Saints of Pandharpur. In the first place, they drew the thoughts of the Marathas away from Islam. Secondly, they created a centre at once literary and religious, and thus made of the race a nation. Thirdly, by their doctrines and writings they improved and enlarged the minds of the Maratha leaders, so that they became the indispensable servants of their conquerors. Fourthly, by belittling caste, they united the Maratha nation, and thus made the way smooth for the coming of a national hero. And lastly, when that hero came, great beyond human expectation—I had almost said human imagination—they made him better than great. They made him modest and just, pure minded and humane.

DISCUSSION.

THE CHAIRMAN (Lieut.-Colonel Sir David Barr, K.C.S.I.), in opening the discussion, said he thought that few of the audience when they came to the meeting had ever heard of the Saints of Pandharpur, but the author had said sufficient to prove that holy men did exist at the time and in the manner that had been related, and that they had great influence over the Maratha race. It was not until he carefully read a book on the rise of the Maratha power—written by the late Hon. Mr. Justice Ranade, a Judge of the High Court of Bombay—that he had any knowledge of the subject; and although the author had, very rightly, deprecated a discussion with regard to the religion of the Hindus, he could not refrain from reading a few sentences showing what were Mr. Justice Ranade's views on the subject. In a chapter devoted to the history of the saints and prophets of Maharashtra, he referred to their teaching as resulting in a religious and political upheaval, and continued: "The supremacy of one God, One without a Second, was the first article of the creed with every one of these saints, which they would not allow anybody to question or challenge . . . All their love has been freely poured upon the intense realisation of the everyday presence of the supreme God in the heart, in a way more convincing than eyes, or ears, or the sense of touch can realise. This constitutes the glory of the saints." Mr. Kincaid had stated that the results of the work of the Saints of Pandharpur were not only to turn the Maratha people from conversion to Islam, but to give them a greater respect for themselves, to learn that caste was not the most important thing, and that the love of God was really the sole motive which should prompt men in this life. He thought it might be said that the pure religion of the Hindus led the people to believe in the love of God, in Tennyson's words—

"That God, which ever lives and loves,
One God, one law, one element,
And one far-off divine event,
To which the whole creation moves."

He thought most people would recognise in that simple teaching the precepts of the religion in which all believed. With regard to the miracles that were performed, and the extraordinary events that happened during the lives of the saints, it must be borne in mind that our teaching from childhood was based upon myth, legend, and history as taught in the nursery, and from that was evolved the faith that grew up in us as we became older. The Hindus were perhaps more liable to these influences than we were. They were the most childlike people in the world; they were very credulous and believed almost anything they were told. They had that "faith like a little child" which the Bible says is the only means of knowing God. English children were brought up to believe in all sorts of stories; but where should we be but for nursery tales? And who would grudge the pleasure children took in peeps into fairyland? They firmly believed in the visit of Santa Claus at Christmas time, and parents devoted themselves at that period to practising a pious fraud upon their children, by seeing that Santa Claus arrived in due time, and that things were exactly as the children thought they would be. In 1887-1888, when he was Political Agent at Rewa, he became a great friend of the head priest, the Swami of Lachman Bagh, who was a very pious and good man, with whom he spent many hours sitting outside his temple, learning a great deal about the Hindu religion and the manner in which it was propagated, and being taught a few of the mantras from the Veda. Some years afterwards, when he was at Indore as Agent to the Governor-General, a great fair, which was held once in a period of so many years, and was attended by Hindus of various castes from all parts of India, was about to take place at Ujjain, a sacred city about forty miles from Indore. It so happened that at the time cholera, in a very virulent form, broke out at Ujjain, and he was asked to do everything in his power to stop the large gathering of 200,000, 300,000, or 400,000 pilgrims taking place, and so prevent the epidemic spreading. The pilgrims had already arrived in their thousands at Indore, and the Maharaja suggested that he (the Chairman) should enlist the assistance of some of the holy men. Accordingly he invited twenty or thirty of them to the Residency, and told them that the pilgrimage to Ujjain was likely to result in a serious outbreak of cholera, and he begged them not to go there, but he was not able to impress them at all. He ascertained that the Priest of the Temple of Juggernaut was the most important of these holy men, and he tried to persuade him, but at first unsuccessfully. He then repeated in a low voice the mantra he had learned years before from the Swami of Lachman Bagh. The Priest at once turned round and said: "Where did you learn that?" He told him, and the Priest asked him if he was the sahib who, when at Rewa, called himself the Chela of the Swami. On replying that he was, the Priest said: "I have heard of you; we will not go to Ujjain." And they did not. He

mentioned that as an instance of the advantage and importance of getting into touch with the people, and as showing how bread cast upon the waters in that way returned after many days.

Colonel J. M. Hunter, C.S.I. (late Political Agent in Kathiawar), thought the paper and the discussion upon it were not only of interest to the student but had a political and administrative value. The more this country knew of India and India knew of this country, the better it would be for both. There could be no doubt that a study of the language, the religion, and the customs of the people of India led to a more sympathetic administration of the country. Indian friends had often spoken to him with gratitude and appreciation of those European officers who, like the author, took the trouble to study the language and customs of the people, because they always seemed to feel that any disputes that might arise would be decided with greater justice and consideration for their feelings. He thought the Royal Society of Arts was doing a great and patriotic work by offering opportunities for the discussion of questions bearing upon the religion and manners of the people of India, because they tended to strengthen the bonds of union which already existed between the two countries. The paper gave rise to one or two very interesting reflections. In the first place, one could not fail to be struck with the shrewdness of the sages to whom reference had been made. The author had given the dignity of saints to many of them, and he supposed men who could perform such stupendous miracles as changing stone walls into chargers, tilting on the top of tigers and milking tigresses, were entitled to that dignity; in fact, the title of the paper might have been "The Sporting Saints of Pandharpur!" The so-called anchorites were really men of the world with a very shrewd knowledge of human nature, because they knew that the most successful way of rendering a cult popular was to attach it to some dominant personality such as some of the incarnations of the Hindu Triad. The next reflection that occurred to him was the extraordinary vitality and force of an ancient and popular cult like that of the Hindus. From the time of the defeat of the two leading Rajput tribes by Mahomed Ghori to the overthrow of the Mohammedan Empire by the Maratha Confederacy, a period of some 600 years elapsed, and, during that time, there was intimate social intercourse and intermarriage between the devotees of the two cults, the Mohammedan and the Hindu. Colonel Watson, in his book on the Mohammedan rule in Gujerat, said it was the custom of the Mohammedan conquerors as soon as they occupied a country to take all the young women into their zenanas, with the result that the offspring of these unions prided themselves upon being descended from the conquering race. There was no doubt that that gave the Mohammedans an extraordinary power and influence throughout the whole country. It was a remarkable thing that, although the people who held those two religions were both Orientals, and lived in the same houses under similar conditions, every distinction between the Hindus and the Mohammedans had not been obliterated. That, he thought, was explained by the fact that in spite of religious persecution the people maintained their love of their own cult. The old saying of the Pope, that "The blood of the martyrs is the seed of the Church," was no doubt illustrated in that wonderful vitality and force of an ancient and popular cult, and it was found, at the end of 600 years, that the religion was able to weld together all the different parts of the Maratha Confederacy and enable them to subvert the Mohammedan power which had lasted for that period. That gave rise to the question, What should be the attitude of a governing power towards a religion that was hostile at the beginning and no doubt dangerous for the future? It might be said that if it was not suppressed there would always be a risk of it causing rebellion; but he did not think that was so. If an ancient cult was associated with just laws, education, and prosperity, that cult became a pillar of the State instead of a danger; and he believed the Hindu religion was a pillar of the State at the present moment, because it had been treated with such perfect toleration. When St. Paul gave the injunction that the Jews were to be subject to the superior powers because they had been ordained of God, he was not founding a new doctrine; it was as old as the Vedas. That brought him to a comparison between the condition of India at the present time and the condition which existed when the Saints of Pandharpur were able to unite the Maratha nation and again restore their ancient religion and liberty. He believed there was no greater evidence of the justice of British rule than the fact that the natives of India were now fighting on our side in this great war. It was perhaps a long way to go to Bernhardi's book, but those who had read it had probably noticed that one of the reasons the author gave why the British Government had no right to its present place in the sun, nor to be the nucleus of such an immense Empire, was because the British Government had never imposed a State religion upon India. It was a good thing the Government had not done so, because if it had attempted to impose a foreign religion upon an unwilling people, would not our position have been much the same as the position of the Mohammedan Government at the time of Shivaji? One of the most remarkable and striking evidences of the contentment and attachment of the Native States to British rule came before him a few weeks ago, when he received a letter from the Maharanee of Bhavnagar, in which she said: "I hope you will accept the bound volume which I am sending you by post of a year's publications of my weekly newspaper, which I have been editing myself, the object of which is to refute all the abominable falsehoods which are being perpetrated and spread all over India by the Germans." It was impossible to have a more striking tribute than that; and in

spite of those who were detractors of British rule in India, he believed this country could look back upon the past history of the administration of India with pardonable feelings of pride, and look forward with confident hope to a greater and happier future for that interesting country as a member of our great Empire.

SIR H. EVAN M. JAMES, K.C.I.E., C.S.I., said he was afraid he could not follow the author in all the excellent results which he thought flowed from the existence of the poetical saints referred to in the paper. He did not quite understand whether the author meant to convey that the Marathas were made a strong nation and able to defend themselves against proselytising Mohammedans, or whether he merely meant that the saints made the Hindu religion more popular than Islam. If he meant the former, with great deference he disagreed with him, because the Mohammedans were never a great proselytising race in India. They were usually tender towards the conquered Hindus and even around the Mogul capitals the proportion of Mohammedans was quite small. They were inconoclasts, of course, like the Puritans in England. He also could not quite follow the author's statement that the poets made Pandharpur a literary centre. As a matter of fact, there was no Maratha literature in those days, and even the great Shivaji could not write his own name. It was possible that some of the poems might have influenced the language of literary people at a later period, in the same way as Chaucer was supposed to have affected the English language; but otherwise he could hardly see that Pandharpur was ever more than a religious centre, and a very popular place of pilgrimage.

MR. J. S. COTTON said, that though he had never been on pilgrimage to Pandharpur, nor could even claim to know the Marathi language, he might venture to contribute to the discussion from a fresh point of view. Among the MSS. collected by Colonel Colin Mackenzie a hundred years ago, most of which were now in the library of the India Office, there were at least three relating to Pandharpur. Two of them are Sthala Mahatmyas, or Legends of the Holy Place, one in Marathi and the other in Telugu. The latter was of special interest in connection with the temple of Vithoba at Vijayanagar, to which he would refer again, for Telugu was the vernacular of the Rayals (or Rajas) of that place, though not of the people. In addition, there was an English translation (Vol. XIV. No. 17) of a Marathi account of Pandharpur, its legends and its temples, in considerable detail, which had been taken down on the spot in 1807. There was, first, the story of the eponym of the place, Pandlik, here called Pandarika, a name with a Kanarese termination. He was a Brahman so famed for filial piety that the god Krishna came all the way from Dwarka to visit him. Instead of attending to the god, he was so absorbed in his duties to his parents that he only gave the god a brick to sit upon; and to this day the image of Vithoba stands on a brick, *ita* = "brick" in Marathi, from which his name is traditionally derived. Afterwards, Rukhmini, the consort of Krishna at Dwarka, in despair at the long absence of her husband, came in search of him, and there she now stood by his side. It was evident, therefore, that the incarnation of Vishnu worshipped at Pandharpur is not Rama, or even the Krishna of Muttra, but the Krishna of Dwarka. Another story here told was worthy of mention. Perhaps the only temple of Vithoba to be found in the South of India is a magnificent building still standing among the ruins of Vijayanagar, which had never been completely finished, and contained no image of the god. The story there told (*Bellary Gazetteer*, p. 276) is that Vithoba had been conveyed thither from Pandharpur by the Rayal, but that he had found the place too grand for him and preferred to return to his own humble home. At Pandharpur the same story is told somewhat differently. One of his devotees followed him all the way to Vijayanagar, where the god, in response to his fervent entreaties, transformed himself into his Dwarf incarnation as Vaman, so that he could conveniently be carried back. The speaker concluded with some arguments indicating that Vithoba, though not now worshipped in the Kanarese country, may originally have been a Kanarese deity. Bhagwanlal Indraji (*Sholapur Gazetteer*) agreed with Sir R. Bhandarkar that "Vithal" was a Kanarese corruption of "Vishnu." The same authority stated that the oldest inscription in the temple, dated in the thirteenth century, contained two place-names each with a Kanarese termination, one of which was Pandarika, mentioned above. He had since noticed that Sir G. Grierson, in his chapter on Vernacular Literature in the *Imperial Gazetteer* (II. 425), mentions a Krishna poet named Vithala-natha, who wrote in Kanarese. All this tended to show—what there were other grounds for believing—that the linguistic boundary between Kanarese and Marathi formerly extended some distance further north than at present up the course of the Bhima River.

SIR FREDERIC S. P. LELY, K.C.I.E., C.S.I., in proposing a hearty vote of thanks to the author of the paper, said his only regret was that he did not hear it fifty years ago, because then he would have been equipped with a great deal of useful information which he had not obtained until the present moment. Nothing gripped the heart of the ordinary native of India so much as the discovery that his companion knew something about his heroes and saints, names which were household words in the family. The Indians were a nation of mystics; they lived in a supernatural atmosphere, which was always present with them. The stories which the author had narrated possessed for English people a philosophical interest, but to the natives of India they were gospel stories. He desired to mention one instance which showed how intensely present the supernatural was to the natives, and that the age of miracles was not by

any means past in India. Some years ago he noticed, when passing through a village in India, a temple which, from the newness of the masonry, showed that it had only just recently been built. He inquired of the local official why the temple had been built, and was told that it was because of a miracle that had occurred in the village two months previously, when the village cattle were coming back from pasture one evening and the earth opened and swallowed one of them. A temple was built in honour of its memory, and an image of a cow was placed in it. Personally he had no doubt that the little rascal who had charge of the cattle knew more about it than that; probably he had lost the cow, and invented the story to account for its absence.

Sir Mancherjee M. Bhownaggree, K.C.I.E., in seconding the motion, said the paper would appeal very strongly to the mind of the people of India. A very widespread impression existed among many classes there that the English administrator did not so fully sympathise or enter into the lives and habits of the people as was desirable, and that he was always more or less of a stranger to them. The late Mr. Alexander Rogers, whose name was known to many present, and who, like Mr. Kincaid, belonged to the Civil Service in Bombay, after forty years' study of Persian and Oriental literature, rendered many of the works in those languages into English, and it was his (the speaker's) great pleasure a few years ago to co-operate with Mr. Rogers in publishing, for the benefit of the English-reading public both in this country and in India, some of those productions. He desired to emphasize the remark made by the Chairman and other speakers that such instances of the sympathetic study of the language and people of India on the part of European friends and officers carried the conviction to the minds of the people that both their history and mode of life appealed to their consideration and formed a serious subject of study.

The resolution was carried unanimously.

Mr. C. A. Kincaid, in reply, said that Sir Evan James had said he could not understand why he (the author) thought it was a good thing the Marathas did not become Mohammedans. That depended upon the way in which the subject was looked at. Personally, he approached the paper from the Maratha point of view, and he thought that if he was a Maratha he would prefer to remain so, as an Englishman preferred to be an Englishman rather than become the subject of any other government.

TWELFTH ORDINARY MEETING.

Wednesday, March 1st, 1916; George Granville Leveson-Gower in the chair.

The following candidates were balloted for and duly elected Fellows of the Society:—

Barneson, Captain John, 310, Sansome-street, San Francisco, California, U.S.A.

Parrish, Samuel L., Southampton, Long Island, New York, U.S.A.

Sadd, W. A., Chattanooga Savings Bank, Chattanooga, Tennessee, U.S.A.

Tabor, Joseph Matthew, Peninsular House, Monument-street, E.C.

The paper read was—

MAETERLINCK, VERHAEREN ET LES LETTRES BELGES.

By M. Charles Delchevalerie.

La petite nation belge, qui a grandi dans l'estime universelle, dès le début de la guerre, en s'illustrant par la défense de son honneur contre un adversaire dont elle n'ignorait pas la force, cette petite nation que l'Angleterre s'est si magnifiquement appliquée à secourir dans son immense infortune, avait déjà, avant la tourmente, conquis un noble rang, par le mérite et l'initiative de ses enfants, dans la famille européenne. Elle avait, vous le savez, produit des savants éminents, des hommes d'action, des hauts artistes. Et pourtant, au cours des âges, il y a dans ses annales plus de douleur encore que de gloire. Sa situation géographique a fait de son sol un perpétuel champ de bataille où les rivalités des princes et des peuples venaient vider leurs différends.

De Jules César à Charles le Téméraire, de Philippe le Bel de France à Philippe II d'Espagne, de Louis XIV à Napoléon, ce qui devait devenir la Belgique fut une mosaïque changeante de provinces morcelées, passant de siècle en siècle sous des dominations successives. Et cependant, les cruels bouleversements de l'histoire n'ont pas empêché les races jumelles attachées aux rives de l'Escaut et de la Meuse, la Flamande et la Wallonne, d'affirmer leur vigueur et leur volonté de progrès par la valeur et l'éclat des individualités auxquelles elles ont donné la vie.

Nous sommes ici dans la sereine Maison de l'Art. En ces jours, où le réveil de la barbarie agressive a déchaîné sur le vieux monde les aventures de la violence, il est réconfortant d'y pouvoir évoquer, pour l'honneur de cette petite nation qui reste la plus touchante victime du grand drame, la beauté du culte de l'idéal, la grandeur de ce qui ne peut mourir. Les Huns ont pu déchirer et mutiler la Belgique, ils ne lui enlèveront pas sa couronne. Ils n'ont pu que la faire briller d'une plus pure clarté en permettant qu'on y ajoutât les joyaux d'un nouvel héroïsme.

Ses gloires artistiques, dans le domaine de la peinture et de la sculpture, vous les connaissez

depuis longtemps, et l'an dernier, à cette même tribune, l'érudit critique d'art qu'est M. Paul Lambotte vous en a excellemment rappelé l'opulence et la diversité. Depuis quelque trente années, le patrimoine intellectuel de la Belgique s'est enrichi d'un autre trésor, et c'est de celui-là qu'à mon tour je voudrais, de mon mieux, signaler quelques unes des merveilles, à la faveur de ce bref entretien.

La récente floraison de la littérature de langue française en Belgique est un admirable et surprenant phénomène, qui mérite de retenir l'attention de tous les lettrés du dehors. Il a d'ailleurs, jusqu'en ces derniers mois, provoqué l'éclosion d'un grand nombre d'études critiques, et l'une des dernières, due à un savant professeur anglais, M. Jethro Bithell, est un modèle d'analyse consciencieuse, compréhensive et sympathique.

Avant 1880, on peut dire que la littérature originale était chez nous presque inexistante. Sans doute, en des temps lointains, les grands chroniqueurs Froissart et Comines naissent sur le sol belge; belge est aussi, par l'origine, ce grand Européen du dix-huitième siècle qui s'appelle le prince de Ligne. Ce sont là des prodiges isolés, des monstres indépendants du milieu où le hasard les fait surgir.

Au dix-neuvième siècle il faut à la Belgique cinquante ans de vie nationale indépendante pour que, dans les limbes où s'évertuent de ternes polygraphes, s'éveille une conscience littéraire enfin vigoureuse et personnelle. Aussi bien, dans un effroyable désert d'indifférence, quel héroïsme ne faut-il pas pour tenter le vain effort d'émouvoir l'improbable lecteur par la vertu des vers ou de la prose! Deux vrais écrivains se manifestent seuls avant 1880: un Wallon, Octave Pirmez, aristocratique rêveur qui distille dans la solitude ses pensées hautaines et mélancoliques, et le visionnaire opulent et pathétique de la "Légende d'Ulenspiegel," Charles de Coster, né à Munich de parents belges. Celui-ci, dans un livre épique et frémissant, retrace, autour d'une figure de héros populaire et familier, le douloureux tableau de l'histoire des Provinces Unies sous la sombre tyrannie religieuse des Espagnols au seizième siècle, et il y a dans son récit toute la ferveur d'un acte de foi patriotique.

Tout à coup, c'est une éclosion spontanée de talents et d'enthousiasmes, comme si la jeune nation, ravie de la prospérité de ses labeurs, voulait extérioriser son allégresse en s'assurant de nouveaux triomphes dans les hautes régions de l'esprit. Disons-le tout de suite, cette révélation d'une élite ne trouve nullement dans le public l'écho auquel elle pouvait s'attendre. Longtemps encore, poètes et prosateurs devront se contenter des suffrages d'un cercle restreint. Mais la confiance est née. Il y a quelque chose de changé. Les écrivains, pleins d'une ardeur juvénile, se sont groupés autour d'un aîné qui est déjà un maître, et qui est un magnifique professeur d'énergie, Camille Lemonnier. Ils ont fondé une revue qui s'appelle la *Jeune Belgique*—titre emblématique!—et d'où vont sortir ceux qui ont aujourd'hui conquis la gloire à l'étranger. C'est l'aurore qui se lève, radieuse, après la longue nuit sans espérance.

Cet éveil d'une cohorte qui va compter bientôt ses batailles et ses victoires mériterait d'être longuement évoqué, car il fut profondément intéressant, mais il faut savoir se borner. Faute de pouvoir dignement parler de tout le monde, nous envisagerons, si vous voulez, nos lettres belges de l'extérieur, en considérant spécialement leurs unités les plus notoires et les plus représentatives, celles dont la renommée a nettement franchi les frontières.

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Dès lors, il est un nom qui s'impose avant tous les autres, c'est celui de Maurice Maeterlinck, célèbre à Moscou comme à Paris, à Rome comme à Londres, lauréat du prix Nobel, interprète éminent de la pensée européenne. C'est en 1885 que la revue la *Jeune Belgique* révèle pour la première fois son nom au public, dans un article du poète Georges Rodenbach, et qui signalait, en même temps que Maeterlinck, deux autres poètes, ses amis, tous deux Gantois comme lui, Charles Van Lerberghe et Grégoire le Roy. Unis dès le collège, ils fréquentaient à cette époque les cénacles parisiens, et Maeterlinck venait de s'y faire connaître en publiant un long poème en prose, "Le Massacre des Innocents," qui est la saisissante transposition d'un tableau de Breughel. Il avait aussi composé un recueil de vers étranges: "Serres Chaudes."

Son théâtre de la première manière, son théâtre de mystère, est en germe dans ce livre, où il note avec d'étonnantes images, subtiles et inattendues, qui attestent une sensibilité aussi fine qu'opulente, le malaise des discordances sentimentales. Ce symbolisme impressionné par l'étude des grands écrivains mystiques, ces conflits silencieux de l'âme et de la destinée, sont la matière de son livre d'essais, de cet admirable "Trésor des Humbles" que vous connaissez tous, et font l'argument de ces petits drames "pour marionnettes," comme il les appelait modestement, qui apportèrent sur les

planches l'émotion d'un "frisson nouveau." La première de ces pièces légendaires, la "Princesse Maleine," paraît vers 1889, imprimée à quelques exemplaires, pour les amis de l'auteur. Mais l'un d'eux veillait, c'était Octave Mirbeau, le grand romancier paroxyste. Dans un retentissant article du *Figaro*, il annonce au monde la naissance d'un nouveau Shakespeare. Éloge terrible, sous lequel un médiocre eut pu rester à jamais enseveli, mais Maeterlinck, dont l'humilité avait été soumise à une épreuve aussi imprévue, n'était heureusement pas un médiocre. Après la "Princesse Maleine," qui est l'un des plus rudimentaires de ses drames, il sut s'amplifier magnifiquement, se diversifier et s'approfondir en écrivant "L'Intruse," et "Intérieur," où le symbole de la mort surgit avec tant de simplicité dans la puissance, et ces poèmes merveilleux de tendresse et de terreur qui s'intitulent "Pelléas et Mélisande," "Aglavaine et Selysette," "La Mort de Tintagiles."

On y trouve des cris d'un lyrisme Shakespearien ; on y trouve surtout une philosophie nouvelle du monde, à la fois mystique et réaliste, et dans les aventures sommaires de ses héros instinctifs, dans leur plainte souvent monocorde, dans leurs tâtonnements guidés par la vacillante lueur du pressentiment, l'émoi provient de je ne sais quelles vérités éternelles dont on voit transparaître le visage.

Ce théâtre angoissant et sybillin, M. Remy de Gourmont le définissait jadis ainsi : "Il y a une île quelquepart dans les brouillards, et dans l'île il y a un château, et dans le château il y a une grande salle éclairée d'une petite lampe, et dans la grande salle il y a des gens qui attendent. Ils attendent quoi ? Ils ne savent pas. Ils attendent que l'on frappe à la porte, ils attendent que la lampe s'éteigne, ils attendent la Peur, ils attendent la Mort. Ils parlent ; oui, ils disent des mots qui troublent un instant le silence, puis ils écoutent encore, laissant leurs phrases inachevées et leurs gestes interrompus. Ils écoutent, ils attendent. Elle ne viendra peut-être pas ? Oh ! elle viendra. Elle vient toujours. Il est tard, elle ne viendra peut-être que demain. Et les gens assemblés dans la grande salle sous la petite lampe se mettent à sourire et ils vont espérer. On frappe. Et c'est tout : c'est toute une vie, et c'est toute la vie."

"On peut dire," ajoute autre part le même éminent critique, "que Maeterlinck a renouvelé la vie, notre façon de sentir la vie. Il y a découvert toutes sortes de petits ruisseaux dont est fait le grand fleuve, toutes sortes de richesses ignorées dont il nous a appris à jouir, avant qu'elles aillent se perdre dans le courant de l'inconscience. Il y a une manière de regarder une rose qui meurt ou de regarder une vieille femme qui prie à l'église, une manière de découvrir de la poésie dans les actes les plus humbles et les plus coutumiers, une manière d'interpréter la vie, toutes les manifestations de la vie, qui n'étaient pas possibles avant lui. Il a multiplié en nous les motifs d'émotion, il nous a appris à chercher la signification de tout, à communier avec tout ce qui a vie ou mouvement et, encore que cette méthode puisse conduire à la sensiblerie et à la préciosité sentimentale, il n'y est pas tombé."

Maeterlinck, en enrichissant notre sensibilité, a contribué de la façon la plus bienfaisante à éclairer la morale moderne, et c'est ce rôle d'éveilleur des consciences qui lui a valu sa légitime gloire universelle. Aussi bien, il a évolué bientôt. Le dramaturge et l'essayiste ont, dans l'observation de la vie, dans l'étude de la nature, dans la méditation, vu s'éclairer leur conception du monde. C'est sous une lumière croissante de confiance et d'optimisme que le lyrisme de Maeterlinck s'exalte dans les évangiles harmonieux qui se succèdent sous ces titres : "La Sagesse et la Destinée," "Le Double Jardin," "Le Temple Enseveli," dans les fables dramatiques de "Monna Vanna," de "Joyzelle" et de cette noble et pénétrante féerie de "L'Oiseau Bleu," qui fut prestigieusement représentée à Londres, et aussi dans les prodiges de compréhension attendrie et profonde que sont "La Vie des Abeilles" et "L'Intelligence des Fleurs." Que la plus claire sagesse soit d'avoir foi dans la grandeur humaine, dans la mystérieuse ascension vers un meilleur devenir, c'est la leçon de ces livres qui célèbrent la santé morale, la bonté et l'énergie. Ils sont, dans leur sérénité lumineuse, très distants de l'angoisse et du repliement du Maeterlinck des débuts, et l'on a critiqué parfois les solutions d'espérance que le penseur en ses pages récentes propose aux vieux problèmes. On a parlé d'optimisme facile, d'éthique adaptée aux besoins des gens du monde. Quoi qu'on veuille conclure de cette controverse, l'auteur de "Monna Vanna" n'en reste pas moins un des guides les plus clairvoyants de l'intellectualité contemporaine, un des plus miraculeux virtuoses de l'art d'écrire, un des hommes qui, sur le chaos des idées et sur le malaise des morales, ont projeté les rayons les plus sûrs et les plus consolants.

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Un autre grand Belge a suivi une courbe correspondante, et il est, lui aussi, honoré désormais, partout où il y a des êtres qui pensent, de l'admiration de l'élite. C'est un poète, c'est le grand poète Émile Verhaeren. Plus âgé que Maeterlinck, il naît aux environs d'Anvers, et nous le trouvons au premier rang quand se lèvent les milices de la *Jeune Belgique;* c'est alors qu'il publie son premier recueil de poèmes, "Les Flamandes," livre enthousiaste, sensuel, débordant, où le patriotisme de la race éclate en couleurs violentes, avec toutes les exubérances d'un culte fanatique. Déjà, sous une forme volontiers brutale et rocailleuse, se marque la puissance du poète, son souffle épique, sa virile envolée, qui le classent dans la famille des grands lyriques. Après avoir chanté amoureusement les prestiges matériels de son pays, il a un retour vers le mysticisme. L'ascétisme et ses rudesses, les rigueurs de la discipline monastique, lui inspirent les poèmes des "Moines," où, quand, par exemple, apostrophant ses héros, il les appelle

Prêcheurs tenant levés vos bras à longues manches
Sur les remords ployés des peuples à genoux,

il aligne des images d'une largeur épique dont on ne trouve guère d'exemple que chez Victor Hugo. Et voici que la crise s'accentue. Trois livres se suivent: "Les Soirs," "Les Débâcles," "Les Flambeaux noirs," qui sont certes parmi les cantiques les plus farouchement désespérés qu'ait exhalés la détresse humaine. C'est la plainte d'une âme malade et qui doute, qui se replie et qui saigne. Une atmosphère de deuil et de néant plane sur ce chant solitaire, qui évoque l'horreur de l'être perdu dans les effrois de l'hiver et de la nuit, dans le silence des étendues indifférentes, dans l'hostilité glacée des ténèbres qui ne s'éclaireront pas. La folie est au bout d'un tel soliloque.

Heureusement la crise ne dure pas. Dans le ciel orageux, un rayon finit par luire, présage des hautes clartés futures, et cette promesse du retour à la lumière s'appelle les "Apparus dans mes Chemins." Cependant, le poète a cessé d'analyser sa maladie et sa douleur personnelles. Il s'est tourné vers le monde extérieur. Il y a trouvé, dans le drame social ambiant, des thèmes pathétiques nouveaux. L'exode des villageois vers les cités, la misère des bourgades de Flandre, les symboles éternels qu'un grand inspiré peut tirer du spectacle des images traditionnelles et familières, donnent naissance à ces recueils caractéristiques, que nul autre n'aurait pu écrire, et qu'emplit le souffle fraternel d'une charité véhémente: "Les Villes Tentaculaires," "Les Campagnes Hallucinées," "Les Villages Illusoires." Désormais, le spectacle du monde va, dans l'âme de ce grand visionnaire, se résoudre, comme chez Maeterlinck, en paraboles de confiance et d'énergie. Les puissances qui régissent l'effort humain, les Lois, les Vérités en devenir, l'Harmonie vers laquelle tend éperdument le labeur obstiné des générations, hantent sa pensée, animent ses poèmes démesurés. Ils sont pleins d'une ferveur enivrée. "Les Forces Tumultueuses," "Les Visages de la Vie," "La Multiple Splendeur," "Les Rythmes Souverains," voilà les titres de ces livres où s'exalte l'allégresse de penser et de croire, où l'univers de l'esprit et de la matière se meut selon le rythme du plus généreux espoir. Il semble que par instants, dans ces strophes palpitantes, on sente l'âme même de la vieille Europe se hausser vers les horizons radieux.

La vie est à monter, et non pas à descendre,

s'écrie-t-il, et ailleurs encore, en vingt vers comme celui-ci:

Vivre, c'est prendre et se donner avec liesse!

cet apôtre de la plus haute solidarité humaine formule le réconfortant crédo de son âme apaisée, et que chaque matin nouveau, semble-t-il, rend plus juvénile et plus résolument enthousiaste.

De tels hommes sont des bienfaiteurs parcequ'ils exaltent magnifiquement la beauté de l'existence et donnent au plus humble conscience de la noblesse de son obscurité. Comme Maeterlinck, Verhaeren devait trouver, pour flétrir les sauvages auteurs de la guerre actuelle, des accents d'une exceptionnelle éloquence, et les poèmes indignés dans lesquels il a célébré le deuil de la patrie innocente sont parmi les pages les plus émouvantes que l'affreuse tragédie ait inspirées.

Aussi bien, Verhaeren n'avait pas attendu la tourmente pour proclamer avec la ferveur touchante et têtue de sa race sa religion du sol natal. On l'a vu, son ouvrage de début est un cantique chaleureux à la gloire des Flandres. L'image de la petite patrie transparait dans presque tous ses livres. Et depuis quelques anneés, ce sentiment filial l'a hanté au point qu'il a commencé la publication d'une série de cahiers à la louange de la terre des ancêtres. Déjà plusieurs recueils de cette suite ont paru, sous ce titre général: "Toute la Flandre." Tous les prestiges du passé, héroïque ou familier, déroulent dans l'âme du grand poète une fresque somptueuse et pathétique. Comme les malheurs de la Belgique ont dû retentir profondément en lui, et comme il était qualifié pour s'agenouiller

devant la divine meurtrie quand, dans un de ses récents poèmes il la salue de ce vers poignant :

Tu te grandis si haut que tu es solitaire !

Écho frémissant des émois et des espoirs de l'époque, miroir plus intime de la terre des aïeux, le talent de Verhaeren a prouvé une autre maîtrise encore quand, dans les poèmes confidentiels de ses "Heures claires," il a célébré, dans l'effusion, dans la sérénité ravie, la secrète et lumineuse exaltation du bonheur domestique. Pour dire la joie loyale et durable d'aimer et d'être aimé, ce violent, cet impulsif a rimé les strophes les plus délicates, les plus gravement attendries, et ce recueil d'intimité est parmi les plus purs chefs-d'œuvre, les plus sobres et les plus noblement inspirés dont se soit enrichie la poésie du sentiment.

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Un des critiques avertis de nos mœurs, M. Dumont-Wilden, a jadis appelé la Belgique le pays des marchands. Par esprit de réaction sans doute—et c'est chose curieuse à constater—la littérature de ce peuple positif est surtout abondante en poètes. Poètes, et grands poètes, les deux écrivains de génie reconnu dont je viens d'essayer d'esquisser la silhouette. Ces deux-là nous représentent devant l'universalité des lettrés ; vingt autres moins illustres, dont je voudrais cependant citer au moins les noms, dans une très brève revue, mériteraient de retenir longuement votre curiosité par la profonde et sincère originalité de leur inspiration. Rien de plus varié que le bouquet de leurs poèmes ; chacun colore son lyrisme des nuances de sa sensibilité. J'ai nommé tout à l'heure Georges Rodenbach. Singulière destinée que celle de ce chantre du regret qui, vivant dans le tumulte de Paris, y reste fidèle au souvenir des béguinages flamands, y demeure le nostalgique et tenace évocateur de Bruges la morte, de ses canaux léthargiques où les cygnes en silence voguent sur l'eau verdie, dans le miroitement du ciel paisible. Un doux lyrisme visionnaire, précieux et dolent, caractérise, dans ses nouvelles et ses vers, les symphonies atténuées, un peu monotones, où se complaît sa muse amoureuse de la solitude et du crépuscule. Ses livres ont au surplus des titres emblématiques, ils s'intitulent "Le Règne du Silence," "L'Art en exil," "Musée de Béguines," "Les Vies Encloses," "Le Rouet des Brumes," "Le Miroir du Ciel Natal." Avec un talent très personnel, en des chansons dont la musique amortie rappelle le ronron du rouet des vieilles fileuses, Grégoire le Roy s'apparente, comme Rodenbach, à la famille des grands nostalgiques. Georges Marlow est, lui aussi, un harmoniste de la même phalange, cependant qu'Albert Giraud, plus classique, en des strophes qui unissent la netteté des médailles antiques à la somptuosité de coloris des maîtres flamands, proclame d'une âme plus virile et plus hautaine son dédain du présent et son lancinant regret des grandes époques où pour lui "l'action était la sœur du rêve." A côté des virtuoses de la nuance, il représente un art de décor et de perfection plastique d'une rare noblesse, et dont l'émotion est si secrète qu'elle n'est pas souvent apparente.

Ces poètes, comme le délicieux enlumineur Max Elskamp, qui recrée dans ses poèmes la naïveté archaïque de l'imagerie et de la chanson populaires, se réfugient dans le mirage des temps disparus. Il en est d'autres, parmi les meilleurs, qui se sont créé un univers à eux, rayonnant, féerique, irréel, dans lequel les fantômes issus de leur pensée miment les épisodes du drame éternel. Leur humanité est à la fois légendaire et contemporaine. Au premier rang de ces magiciens on peut certes classer le regretté Charles Van Lerberghe, en qui Maeterlinck salua jadis le maître affectueux et sûr de son inspiration dans le domaine dramatique. Il n'est pas d'atmosphère plus fluide et plus suavement lumineuse que celle de ses poèmes. Dans ses "Entrevisions" et dans sa "Chanson d'Ève," il ressuscite en vérité la jeunesse de la terre en faisant surgir, dans la splendeur d'une aube surnaturelle, des visions dont la simple grâce et la pureté enfantine évoquent la beauté des chefs-d'œuvre florentins. Chacune des claires pages qu'on doit à ce roi d'un monde émerveillé donne au lecteur la joie de la perfection réalisée.

Le Wallon Fernand Severin nous la donne aussi, cette impression, dans les strophes fières et confidentielles, de forme toute racinienne, de ces recueils qui attestent son tempérament d'intimiste fervent : "Un Chant dans l'Ombre," "Le Don d'Enfance," "La Solitude Heureuse." Ce "Don d'Enfance" qu'il célèbre religieusement, c'est celui du poète, qui garde devant la beauté du monde la pureté d'un regard ingénu, d'une effusion toujours candide et généreuse. Pour dire l'accent profond de ses extases, il trouve des harmonies d'une ineffable délicatesse.

Tandis que la *Jeune Belgique* paraissait à Bruxelles, une autre revue qui fit également époque naissait à Liège, la *Wallonie*, sous l'impulsion d'Albert Mockel. Critique d'une pénétration rare, celui-ci est aussi parmi les plus nobles de nos poètes, et ses "Contes pour les Enfants d'Hier" revêtent d'une lumière enchantée des fables pleines de symboles héroïques et gracieux. Du poète Isi Collin on a représenté

l'an dernier à Londres une délicieuse parabole, "Sisyphe et le Juif Errant," qui a fait connaître aux lettrés anglais le talent de cet heureux évocateur de visions païennes. Ivan Gilkin composa jadis de vigoureux poèmes pessimistes dans la manière baudelairienne. Paul Gérardy montre dans ses "Roseaux" la verve d'un ingénieux trouvère, et Louis Delacre a noté de façon subtile et délicate les sensations de la vie provinciale. . . .

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Mais on ne peut, hélas ! citer tout le monde. . . Ceux dont j'ai parlé sont surtout des rimeurs. Mais, répétons-le, en ce curieux pays, les prosateurs, romanciers et conteurs ont aussi, pour la plupart, des tempéraments de poètes.

Tel est certes le cas de celui qui fut leur maître à tous, au moins par l'énergie et la ferveur de l'exemple, Camille Lemonnier. L'un des premiers livres qui lui assurent la notoriété est un frémissant cahier d'impressions qu'il avait recueillies sur le champ de bataille de Sedan, "Les Charniers." C'est le moment, hélas, de rappeler que Maupassant salua cet ouvrage comme l'un des plus éloquents qui aient flétri les horreurs de la guerre. Mais comment passer sous silence l'effort d'un Lemonnier ? Quarante ans d'écriture, soixante volumes amassés, des batailles et des victoires, une vie vaillamment dépensée à combattre pour le beau et le vrai, au milieu de l'indifférence : cette vie même est une œuvre de constance et de loyauté. Actuels ou situés hors du temps, ses romans et ses contes sont des récits de poète merveilleusement descriptif plutôt que des travaux d'analyste. Lemonnier a le culte enthousiaste de la vie, elle le requiert sous tous ses aspects ; après avoir évoqué l'humanité rustique dans "Un Mâle" et "Le Mort," il écrira des évangiles légendaires comme "Adam et Ève" et "Au Cœur frais de la Forêt," ou il étudiera des psychologies plus complexes dans "L'Arche," dans "Le Possédé," dans "L'Hallali" ; il s'élèvera dans "Ceux de la Glèbe" et dans ses "Noëls Flamands" au rang des plus prestigieux conteurs. Tantôt l'intimité le tente, et tantôt la grande fresque sociale ; ses récits s'inspirent délicieusement de la poésie du milieu ; tantôt il nous place dans le décor discret de la petite ville flamande aux pignons dentelés, et tantôt dans la fraîcheur transparente des matins sur la Meuse, tandis que sur la colline le soleil montant dénoue les écharpes du brouillard.

Écrivain puissant, abondant, enthousiaste, il a dressé un monument à la beauté de la patrie en la décrivant dans les huit cents grandes pages de sa "Belgique" et il en a exalté les gloires artistiques en de nombreuses monographies qui attestent une exceptionnelle richesse de compréhension.

Autour de cet aîné si valeureux, qui mourut il y a peu d'années sans avoir jamais défailli dans l'épreuve, voici une légion de conteurs, qui ont entassé des livres parfumés de l'odeur du pays. De fait, il y a peu d'exemples chez nous d'écrivains indifférents au décor qui les entoure. Chacun se rattache à sa contrée. C'est dans la région flamande Georges Elkhoud qui, avec une force et une émotion fraternelle qui rappellent Gorki, se penche sur les irréguliers, sur les errants de la lande anversoise ; c'est Georges Virrès qui nous situe dans les villages de Campine, et Léopold Courouble dont l'humour retrace les mœurs de la petite bourgeoisie bruxelloise. En Wallonie, Maurice des Ombiaux et Louis Delattre se partagent leur Hainaut familier en des récits joyeux, où se reflète la santé morale d'un peuple honnête et laborieux ; c'est Edmond Glesener, vigoureux ironiste, le mieux doué peut-être pour l'envergure du roman ; c'est Hubert Krains, qui note avec la pointe dure d'un aquafortiste la pénible vie des paysans de Hesbaye, et Georges Garnir, sentimental et souriant. . . . Chacun est roi de son petit domaine ; chacun a si bien parlé de sa terre qu'il nous l'a fait aimer davantage ; chacun a sacrifié sans préméditation au meilleur patriotisme.

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Veuillez excuser, mesdames et messieurs, toutes les lacunes de ce résumé, à la fois trop long et trop court, dans lequel, par simple souci de justice, j'eusse dû faire rentrer bien d'autres noms encore, et de considérables, comme ceux d'Eugéne Demolder, qui retrouve la saveur des peintres de Hollande pour en aviver l'attrait de ses nouvelles fleuries, et d'Edmond Picard, qui a donné tant de vie à ses scènes du monde judiciaire.

Mais tout ne peut se dire en une heure. J'ai voulu simplement signaler à ceux qui pourraient l'ignorer, combien depuis un quart de siècle notre Belgique s'est illustrée dans les hautes régions de la pensée et de la sensibilité par l'éclat de sa renaissance littéraire. Elle représente maintenant, dans les lettres françaises, une des provinces les plus riches et les plus fécondes. Et, vous me permettrez de le faire remarquer, ce qui distingue nos écrivains, c'est la sincérité désintéressée, le courage silencieux de leur effort. L'indifférence du public, orienté vers la production étrangère, a fait qu'en dehors

du journalisme on ne peut chez nous vivre des travaux de la plume, si bien que l'écrivain professionnel y représente une espèce humaine à peu près complètement inconnue. Les poètes et les prosateurs y sont cependant nombreux, tout comme s'ils étaient encouragés ; ils travaillent dans le loisir que leur laisse une autre profession plus lucrative, ils écrivent pour satisfaire un besoin de leur être pensant et sensible, ils écrivent parce qu'ils ont quelque chose à exprimer.

Ce fait qu'ils n'ont guère eu à espérer jusqu'ici que les suffrages d'une élite restreinte est pénible à constater, mais il faut reconnaître que de la volonté des écrivains, exempte de toute avilissante idée de commerce, de toute courtisanerie à l'égard de la foule, ne peuvent naître que des œuvres singulièrement honnêtes et nobles. L'effort gagne souvent en dignité ce qu'il perd en profit. Il est loyal et solitaire, il puise sa force en lui-même, et ne se presse pas pour produire des œuvres hâtives et mal méditées.

Chacun chantant pour sa propre joie intime, exalte ainsi les meilleurs dons de sa race. La fastueuse imagination flamande, l'ironique et tendre sensibilité wallonne, fleurissent miraculeusement et durablement dans les contes et les poèmes, après avoir triomphé dans les tableaux et dans les musiques. Il y a pour l'observateur sympathique une source d'émotion pénétrante dans le spectacle de la ferveur filiale avec laquelle nos littérateurs, à chaque page et presque inconsciemment, magnifient les prestiges de la petite patrie et la douceur de vivre sous son ciel. C'est un hommage permanent, un cantique perpétuel. C'est dans leurs pages la saine odeur du pays natal qu'on respire : il n'est pas un d'eux qui ne soit imprégné de cette piété jusque dans les fibres les plus secrètes de son être. Et de la sorte, en chantant leur pays avec tant d'amour, ils l'ont fait mieux connaître et mieux aimer encore. Ils ont, par le miracle de leur intuition attentive, exprimé les mille raisons que nous avons de chérir la terre des ancêtres. Ils l'ont glorifiée dans le temps et dans l'espace. Ils ont dit la clarté changeante de ses jours paisibles, la grâce de ses collines, la sérénité de ses plaines, le sourire de ses rivières, la bonhomie, la vaillance tranquille, la stoïque volonté d'indépendance de son vieux peuple loyal et infatigable. Ils ont puisé de la beauté profonde et durable à l'humble source des émotions familières. Ils ont ainsi, parce qu'ils ont eu raison de chanter, conquis des provinces idéales, à jamais inaccessibles aux ravages de l'agresseur. Ils ont rendu plus précis, plus gracieux et plus touchant le cher fantôme qui là-bas, sur la terre meurtrie, palpite dans les plis des drapeaux déchirés. Laissez-moi les saluer en terminant, leur dédier un peu de la gratitude du peuple dont ils ont enrichi le plus noble patrimoine. Grâce à eux, on sait comment chez nous, de quelle façon pieuse, enthousiaste et tenace, l'attachement au sol natal s'exprimait dans la sécurité joyeuse, avant d'être, par les surprises du malheur collectif, stimulé jusqu'aux plus beaux sursauts de l'héroïsme.

The Chairman (George Granville Leveson-Gower), in proposing a hearty vote of thanks to the author for his interesting paper, said he thought he was rightly interpreting the feelings of those present in saying how much they had appreciated the lucid, forcible, eloquent, and deeply touching manner in which the author had fulfilled his task that afternoon. He had touched upon one or two points which were extremely interesting, and would well repay further consideration and amplification. One striking point was the quality and character of the various writers whom the author had so eloquently described. Some of those writers were known to those present before, and they would probably study them all with increased interest after having heard the paper that afternoon, in which the author had touched on the wide and varied store of riches in Belgian literature of modern times. It occurred to him that possibly the deep love of country, the mixture of tender mysticism and ardent patriotism, and the wide view of human life and human thought manifested by the writers mentioned, might have arisen in the strange and touching vicissitudes which Belgium had undergone, not only recently but in the past also. Many of those present probably knew the deep quietude and charm, the broad meadows slightly veiled with mist, the old-world towns of grey stone with their wonderful architecture, which were characteristic of Belgium in normal times. That country had in the past been swept by storms of civic passions and commotions and by hostile invasion. Such contrasts would be likely to produce in the inhabitants strange reflections, at times vehement and at times thoughtful, which might express themselves in the form of wonderful poetry of various kinds. Those who remembered how Mr. Maeterlinck had come home, so to speak, to many English people, as well as to those in every civilised country of Europe, would concede that one of the reasons of his appeal was his deep serenity, his extraordinary sincerity and his monumental simplicity—three qualities which were essential to a great writer. He had personally been struck by those three qualities when he had the honour of meeting Mr. Maeterlinck over twenty years ago and showing him over the Houses of Parliament, of which he (the speaker) was then a

member. The more one looked at his work the more one saw the inner meaning which was guiding and illuminating the whole of it. He had not only the gift of presenting facts clearly but he had also the gift of making those facts, as it were, germinate and grow within one's mind. His talents and genius had been familiarised to English people by the many stage representations of his works that had been produced in recent years, and those who were unable to follow him in his own language must feel deeply indebted to the very admirable translations by Mr. Alfred Sutro, which he thought approached as near the ideal as it was possible to attain in that most difficult of all the arts. Verhaeren and the other writers to whom the author had alluded were perhaps less generally known in this country, but they were very widely known and appreciated in France. During the previous autumn he had come across a very charming little anthology of French poets, edited by a young French poet of the present day, in which a large number of Flemish, Walloon, and Belgian poets were included, and in which full homage was paid to their manifold and exceptional merits. It must, he thought, be very satisfactory to people of Belgian nationality to reflect that beyond the confines of their own country their literature had established itself in a firm and recognised position. Some might imagine that it was not fitting at the present time, when everyone was beset by the stress and anxiety of the world-wide cataclysm which came home to them individually and nationally, to seek relief in literature and poetry from the thoughts and anxieties that oppressed them. That was not his own view. He thought it was a good thing to seek such relief not merely in a healthy spirit of cheery optimism—like Drake, who finished his game of bowls and then went out to defeat the Armada—but because it was good to steep one's soul in things of the spirit, and to keep the flame of the ideal bright within one, and the writers that had been mentioned in the paper that afternoon were all deeply impressed with the importance of the ideal. By that means one was able to endure and best fit oneself to meet whatever calls the present time of stress and trial and anguish might bring upon one.

The resolution of thanks was carried unanimously, and the CHAIRMAN then addressed the following words to the author:—

Monsieur,—Nous avons été heureux de vous recevoir ici et nous tenons à vous dire combien nous avons goûté l'admirable conférence que vous venez de nous donner. Cette conférence démontre, si je puis m'exprimer ainsi, qu'il y a un poète belge présent ici sur cette plateforme, car il y a l'accent de la poésie dans ce que nous avons eu l'honneur d'entendre aujourd'hui. Il est à espérer qu'avant longtemps votre belle patrie sera libérée pour toujours des hordes barbares qui la polluent et l'écrasent en ce moment. Je désire moi-même exprimer l'espoir que lorsque les termes de paix seront enfin signés, les œuvres d'art se trouvant actuellement dans les musées de l'Allemagne et qui proviennent de la Belgique, de la France et de la Pologne, devront être restituées, en dehors de l'indemnité large qui devra vous être allouée en réparation de l'œuvre de destruction brutale organisée dans votre pays et au cours de laquelle on a livré aux flammes des œuvres d'art qui devraient à tout jamais être sacrées pour tout peuple qui s'appelle civilisé.

The meeting then terminated.

COTTON MACHINERY WANTED IN ARGENTINA.

The Province of Tucuman is practically a one-crop region, the cultivation of sugar-cane having outstripped any other agricultural industry. The land is, however, suitable for other things. Some tobacco has been grown there, and last year linseed was successfully cultivated, a recent sale in Rosario of 600 tons of linseed from Tucuman demonstrating this capability of the soil.

Much of the northern region of Argentina has been subject to sporadic efforts to grow cotton. That it is suitable for cotton is evidenced by the tradition that the name "Tucuman" signifies, in the language of the indigenous people, "cotton," and the museums at Tucuman and elsewhere have samples of cloth by the natives which was woven from cotton grown there before the Spanish occupation. The cotton plant is seen in several isolated fields, and serious studies have been made by agronomists to encourage its cultivation, because of the large consumption of cotton cloth in Argentina.

The present Government of the Province of Tucuman, supported by the National Government's Department of Agriculture, is desirous of introducing the cotton industry. To that end it invited the attention of a group of cotton-men to study the possibilities of the province. These gentlemen are promised a concession of 5,000 hectares (12,355 acres) of land from the province at a moderate price for the cultivation of cotton. The concessionaires are to receive sufficient irrigation from the public irrigation works already established or projected. On their side they agree to bring from Spain 1,500 workmen, who are to form the nucleus of a colony in these cotton fields; they are to erect a factory on the land, which will be equipped with the most modern machinery for utilising the agricultural product, and among the workmen are to be many who have been skilled in weaving cotton cloth by such modern machinery.

According to a recent report by the United States Commercial Attaché at Buenos Aires, the project is assuming practical shape, and the hope is warranted that within a short time the conces-

sionaires will be in the market for the purchase of the equipment for these modern cotton-mills. The Commercial Attaché, at the invitation of the Governor of the Province of Tucuman, was permitted to study the proposition at first hand, and was given the opportunity to visit not only the city of Tucuman but the adjacent region, which, in all probability, will be selected for this new industry.

ENGINEERING NOTES.

Electric Traction on Mountain Railways.—The first actual tests on the Chicago, Milwaukee and St. Paul Railway's newly electrified mountain divisions in Montana were made on December 8th by officials and directors of the system, accompanied by engineers of the General Electric Company. The completed sections of the electrified district were traversed in three special cars drawn by one of the new 260-ton 3,000-volt electric locomotives. Passenger-train tests were made at speeds up to 70 miles per hour, after which the same locomotives were used in tonnage tests of goods trains, pulling 2,500 tons at a uniform speed of 16 miles per hour. At the conclusion of the tests the president and other officials who witnessed them expressed gratification at their complete success. The regenerative braking device included in the equipment of the 3,000-volt locomotives proved under the actual tests to be entirely successful. It was seen that the use of the air-brakes had been practically done away with except for station stops and emergency uses, and that an enormous saving could be expected in the lessening of wear and tear on track and equipment. The constant grinding of brake shoes on wheels is nearly eliminated. It is expected that the all-steel transcontinental trains of the railway will soon be operated electrically over the Continental Divide.

Electric Lifts.—In a paper read before the Association of Supervising Electricians, Mr. H. Marryat discussed the construction and management of electric lifts. Dividing lifts into two broad classes, sheave-driven and drum-driven, with the gear placed at either the top or the bottom, he said that all work on the see-saw principle. Not only is the car and its attendant, if any, fully counterweighted, but also a proportion, usually 40 per cent., of the maximum load. In these conditions the lift descending empty takes almost as much power as when ascending fully loaded, and exactly the same power as when ascending with 80 per cent. of its full load. On the other hand, with an average load of 80 per cent. of full load, it takes practically no power either ascending or descending. This system of counterbalancing part of the load accounts for the extraordinary efficiency of electric lifts. Compared with hydraulic lifts, their first cost is much the same, though a completely automatic lift may cost a little more than an ordinary hydraulic lift; but the running costs are always less, and in the author's experience modern examples cost for electric current about one-tenth of the water bill for similar hydraulic examples. The hydraulic lift uses the same amount of water whether the car be quite empty or fully loaded. The energy required for starting and accelerating a carefully balanced electric lift exceeds that of the actual running, and therefore a skilled attendant will effect great economy over an unskilled one, who will sometimes make two or three shots before attaining floor level. In this respect a push-button lift gives maximum economy, because it makes only one start for each journey, and automatically finds its own floor level. In regard to maintenance costs, the balance is again in favour of electric lifts. The adjustment of counterweights is an important matter. The maker, not knowing what the average load is going to be, has only the maximum load to guide him, and he usually assumes an average load of 40 per cent., and balances accordingly. But this estimate may prove quite wrong. Actual economies of 50 per cent. and upwards have been realised by attention to adjusting the correct counterweighting of lifts to the average load.

Gas from Wood.—It may be mentioned that this material is in more or less constant use in many of the smaller Australian gasworks. Only certain classes of timber are suitable for the purpose, the best being those of the box and red-gum varieties, which are intermixed with coal to the extent of about 25 per cent. By introducing the wood it is claimed that the resulting product offers many advantages over ordinary neat coal gas, chiefly owing to the fact that napthalene troubles are almost eliminated, while there is some considerable reduction in the amount of scurf deposited on the retort walls. In Australia it is found that the average yield of gas amounts to about 12,000 cubic feet per ton of wood carbonised; but the great drawback to the method of working is the charcoal which remains behind after the completion of the distillation. It is usual to separate the charcoal from the coke and to make use of it for heating the retort furnaces. As employed for power purposes, wood gas is invariably manufactured from waste material such as sawdust and shavings, or even leaves, and, except for detarring and washing, is consumed in the crude form and unmixed with any other gas. Suction plants designed for using wood waste are capable of working with material of any description between dust and lumps six inches in diameter. In general, in addition to the generator, it is necessary to install a condenser, washer and tar-extractor, so that all the connecting-pipes to the engine may be kept perfectly clear. The moistness of the wood has an important effect on results, and in the event of the water content being greater than 60 per cent. preliminary drying should be resorted to, otherwise difficulties will be encountered with the fire. Wood gas as obtained by distillation in gasworks has a calorific value of about 400 B.Th.U. per cubic foot, whereas that generated by the suction plant is

approximately 160 B.Th.U. The latter figure it will be noticed is, if anything, somewhat higher than the corresponding value of the gas obtained with anthracite producers. A successful method of using wood waste is that employed in the Brooks dual scheme. The wood is primarily carbonised in retorts in the ordinary way, when a gas equivalent to about 13,000 cubic feet per ton and having a calorific value of from 375 to 390 B.Th.U. is obtained. The resultant charcoal, which amounts to one-fifth of the original weight of the wood, is then transferred to suction producers and the mixed gas is employed for power purposes. The above particulars are from the *Times* Engineering Supplement.

The Evolution of the War Aeroplane.—A leading article in the *Engineering Record* of New York on the above subject concludes as follows: "Powerful machine guns are now regularly mounted on war planes, together with suitable devices for dropping incendiary and high-explosive bombs; but the time seems now at hand when still further evolution in powers of offence and defence is at hand. The Russians are reported to have developed some giant flying machines with double fusilage and engines of much greater power than hitherto tried. The French are known to have similar equipment under way, and even in this country experiments along the same line have been actively carried out. If those prove as successful as there is reason to expect, the next year of war will see armoured aeroplanes capable of flying hundreds of miles at great speed while carrying half a ton or more of explosives. Even now some of the largest French planes are equipped with one-pounder rapid-firing guns, and these probably will be replaced with light cannon of still larger calibre ere long. Thus armed and armoured the heavier-than-air machine becomes formidable for offence against raiding air crafts of various sorts. England is also reputed to be building air craft of great power in large numbers. In view of all this, it seems reasonably certain that by the end of the war the aeroplane will be in a position to take its place as a rather reliable means of emergency transportation, perhaps even as an aerial vehicle capable of performing regular service at high speed. The change which the year has produced is of a very startling character, and another year will bring still further surprises. It is certainly the duty of engineers and aviators in our country to see to it that we are not behind in the race for command of the air."

The Mixed Australian Railway Gauge.—Recently, at Tocumwal, New South Wales, a successful demonstration of the third-rail system, together with the Brennan patent switch (of torpedo and mono-rail fame) and the Wilkin's common-rail switch, was carried out in the presence of a representative gathering. Included amongst those present were the Governors of four States and the Railway Commissioners and Engineers of the Commonwealth and the States. The object of the display was to illustrate the ease with which the break of gauge between the Victorian and New South Wales systems 5 ft. 3 in. and 4 ft. 8½ in. respectively, can be overcome, and, judging by the smoothness which marked the trials, the difficulty has been solved. The experiments were carried out on a specially laid track outside the local station. The points and switches were designed by Mr. Wilkin, Interlocking Engineer, while the line was laid under the supervision of Mr. Henry Deane, M.Inst.C.E., late Engineer in Chief of the Commonwealth Railways. The object of the Government was to test the Brennan patent switches under service conditions, and for the purpose a series of switches, points, and other apparatus was laid down on a plan that would be met with under working conditions where a break of gauge was to be overcome.

Mr. Wilkin also installed a switch of his own design for a change of common rail which enables engines of both gauges to be turned on the one turntable. The first test was the passing of a New South Wales engine and train over a mixed gauge cross-over, which connects together two parallel lines of different gauges. Then a Victorian train did likewise. A feature of this cross-over was that it was worked by one lever only. Moving farther up the line, the visitors were then shown a Victorian train running on a three-line track turning into a Victorian gauge siding. Tests were then made with the Brennan patent switches, which formed a junction, and which were completely signalled and interlocked. Trains of both States flew over the switches at close on forty miles an hour. Tests were then made with the Wilkin's change of common-rail device, by which means a New South Wales train was brought the same distance from a platform as the Victorian train. The experiments were concluded with the trial of the Wilkin's turntable, on which engines of both gauges can be turned. The New South Wales engineers were highly satisfied with the practicability of the inventions. The representatives of other States will report to their Governments. The upshot and moral of the whole is that our politicians—for it was their fault altering the gauge, not the engineers, who protested—will thereby probably incur several millions of useless expenditure, whatever the means adopted to enable uniformity to be attained.

GENERAL NOTES.

Potassium in Alsace.—In an article in the *Revue Générale des Sciences*, M. Henri Blin describes the deposits of potassium salts in Alsace. They were discovered in 1904, and cover an area of some 50,000 acres. They are bounded on the east by Mulhouse, on the north by Radersheim, on the south by Keiningen, and on the west by Cernay, and are worked at Wittelsheim, to the north of

Mulhouse. Should Alsace again become French, they will form an inexhaustible supply of chemical fertilisers for French agriculture. It is estimated that the beds contain some 3,000,000 tons of pure potash, which at present rates of consumption would supply the world demand for potash for nearly five centuries. The most important constituent of the Alsatian deposits is sylvinite—a mineral in which the chloride of potassium predominates—which can be used as a fertiliser directly after pulverisation.

PORTLAND CEMENT.—Owing to the shortage of German and Belgian supplies of Portland cement, a good deal of attention is being given to the manufacture of this material abroad, in places where limestone, shale, or clay and coal can be obtained of suitable quality and in sufficient quantities to make the manufacture likely to be successful and remunerative. The Queensland Cement and Lime Company has now arranged to establish a works at Darra, near Brisbane. The plant is designed to produce about 40,000 tons of cement per annum. The complete contract for the supply and erection of the plant, which will be of entirely British manufacture, has been placed with Messrs. Noyes Brothers, Sydney. Grinding mills of the combination ball and tube mill type, and a kiln 140 ft. long and 8 ft. in diameter, will be erected; and these, together with all the subsidiary plant, will be electrically driven, direct-coupled wherever possible. The motors are for 3-phase, 50 cycles, 440 volts, and will be supplied with power from generating plant in the works, which will be direct-coupled to vertical high-speed engines. The general lay-out of the plant has been made with the expectation that the works will soon be duplicated and even further increased.

COFFEE CROP OF SALVADOR.—According to a report by the United States Vice-Consul at San Salvador, preparations are now being made to harvest the 1915–16 coffee crop of Salvador, which it is believed will reach a total of 75,000,000 lb.; 60,000,000 lb. will probably be exported. This is considered to be a very good crop and compares favourably with the crop of the preceding year, which was 77,007,000 lb., produced in the following Departments:—Santa Ana, 12,888,000 lb.; Ahuachapán, 8,137,400 lb.; Sonsonate, 5,573,400 lb.; La Libertad, 14,174,400 lb.; San Salvador, 2,480,100 lb.; Chalatenango, 88,700 lb.; Cuscatlan, 489,000 lb.; La Paz, 8,788,600 lb.; San Vicente, 753,000 lb.; Cabañas, 286,300 lb.; San Miguel, 4,861,700 lb.; Usulutan, 18,071,000 lb.; Morazan, 404,700 lb.; and La Union, 11,000 lb. There are approximately 211,000 acres planted in coffee trees in Salvador.

SPANISH HORSE-BEAN CROP.—One of the crops that is largely raised in Andalusia, and is appearing more frequently among the exports, is the horse-bean, or "haba" (*Faba vulgaris*). According to a report by the U.S. Consul at Seville, statistics have been issued recently by the Director-General of Agriculture, showing that the production of "habas" in Spain amounts to 146,975 metric tons (metric ton = 2,204·6 lb.). The area devoted to the cultivation of this legume is 206,910 acres, viz., 87,586 acres in irrigated districts, producing 50,190 metric tons, and 119,324 acres cultivated by dry-farming methods, producing 96,785 metric tons. The districts of Spain in which the crops are the largest are Eastern Andalusia (32,020 tons), Western Andalusia (27,830 tons), and Navarra and the Basque Provinces (12,860 tons).

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

MARCH 8.—CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare." DR. R. T. GLAZEBROOK, C.B., F.R.S., Director of the National Physical Laboratory, will preside.

MARCH 15.—EDWARD PERCY STEBBING, F.L.S., F.R.G.S., Head of the Department of Forestry, University of Edinburgh, "Forestry and the War."

MARCH 22.—REV. P. H. DITCHFIELD, M.A., "The England of Shakespeare."

MARCH 29.—R. W. SETON-WATSON, D.Litt., "Pan-German Aspirations in the Near East."

APRIL 5.—ARTHUR S. JENNINGS, "Painting by Dipping, Spraying, and other Mechanical Means."

MAY 3.—PROFESSOR W. B. BOTTOMLEY, M.A., F.C.S., F.L.S., "Bacterised Peat."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

APRIL 6.—PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India." THE RIGHT HON. LORD ISLINGTON, G.C.M.G., will preside.

APRIL 27.—JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

MAY 18.—SARDAR DALJIT SINGH, C.S.I., "The Sikhs."

Colonial Section.

Tuesday afternoons, at 4.30 p.m. :—

March 28.—Percy Hurd, "Next Steps in Empire Partnership."

April 11.—Sir Daniel Morris, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland."

Dates to be hereafter announced :—

W. A. Craigie, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

Victor Horta, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

Professor T. G. Masaryk, "The Slavonic Peoples."

G. P. Baker, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

Cantor Lectures.

Monday afternoons, at 4.30 p.m. :—

J. Erskine-Murray, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

Fothergill Lectures.

Monday afternoons, at 4.30 p.m. :—

Edward A. Reeves, F.R.A.S., Map Curator, Royal Geographical Society, "Surveying." Three Lectures.

March 27, April 3, 10.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 6...Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. H. J. R. Marston, "The Psychology of St. Paul."

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Hon. W. P. Reeves, "The Balkan States." (Lecture V.)

Engineers, Society of, Caxton Hall, Westminster, S.W., 5.30 p.m. Mr. R. Brown, "Sewage and its Precipitation: Facts and Fallacies from Laboratory and Practical Tests."

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m.

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Mr. G. Turville Brown, "Management of Estates in Mineral Districts and Mineral Valuations."

Geographical Society Burlington-gardens, W., 8.30 p.m. Mr. C. M. Woodford, "Some Little-known Polynesian Settlements near the Solomon Islands."

Medicine, Royal Society of, 1, Wimpole-street, W., 5.30 p.m. Debate on "War Injuries of the Jaws and Face."

Tuesday, March 7...Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. J. Russell, "The Plant and the Soil." (Lecture II.)

Alpine Club, 23, Savile-row, W., 8.30 p.m. Rev. W. Weston, "Annals of Fuji San."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. H. Cox, "Industrial Development."

Zoological Society, Regent's Park, N.W., 5 p.m. Cinematographic Exhibition of African Animals by Mr. H. K. Eustace.

Röntgen Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8.15 p.m. 1. Discussion on "The Injurious Effects Produced by X-Rays." 2. Mr. A. C. Gunstone, "The Use of Inverse Current."

Wednesday, March 8...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. C. R. Darling, "Optical Appliances in Warfare."

Automobile Engineers, Institution of, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. J. L. Hodgson, "The Fan Dynamometer."

Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Mr. S. Langdon, "New Fragments of the Babylonian Book of Wisdom."

Geological Society, Burlington House, W., 8 p.m.

Electrical Engineers, Institution of (Yorkshire Section), Philosophical Hall, Leeds, 7 p.m. Mr. H. Joseph, "Hire and Maintenance of Continuous Current Motors."

University of London, King's College, Strand, W.C., 5.15 p.m. Mr. R. Dmowski, "Poland and Germany."

Medicine, Royal Society of, 1, Wimpole-street, W., 5 p.m. Dr. L. S. Dudgeon, "Experiences in the Gallipoli Peninsula and Eastern Mediterranean."

Thursday, March 9...London Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 5.30 p.m. Annual Meeting.

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Sanitary Institute, 90, Buckingham Palace-road, S.W., 4.30 p.m. Dr. J. W. Mason, "Food Inspection, Standards of Purity for Food Supply in War-Time, and the Utilisation of Condemned Stores."

Royal Institution, Albemarle-street, W., 3 p.m. Professor L. W. King, "Recent Excavations in Mesopotamia." (Lecture II.)

Optical Society, at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. T. F. Connolly, "A Simple Focometer for the Determination of Short Focal Lengths both Negative and Positive." 2. Mr. F. E. Smith, "The Manufacture and Testing of Prismatic and other Compasses."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Mr. E. V. Pannell, "Continuous-Current Railway Motors."

Friday, March 10...Royal Institution, Albemarle-street, W., 5.30 p.m. Sir Napier Shaw, "Illusions of the Upper Air."

Astronomical Society, Burlington House, 5 p.m.

University of London, Bedford College, York Gate, N.W., 5 p.m. Miss H. D. Oakeley, "The International Crisis—the Idea of a General Will."

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Mr. C. Turnor, "The Land and the Empire."

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Medicine, Royal Society of, 1, Wimpole-street, W., 5 p.m. Dr. M. Weinberg, "Bacteriological and Experimental Researches on Gas Gangrene."

Saturday, March 11...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Radiations from Atoms and Electrons." (Lecture I.)

Journal of the Royal Society of Arts.

No. 3,303. VOL. LXIV.

FRIDAY, MARCH 10, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, MARCH 15th, 4.30 p.m. (Ordinary Meeting.) EDWARD PERCY STEBBING, F.L.S., F.R.G.S., Head of the Department of Forestry, University of Edinburgh, "Forestry and the War."

Further particulars of the Society's meetings will be found at the end of this number.

PETER LE NEVE FOSTER PRIZE.

The prize of £10 and a Silver Medal, offered under the Peter Le Neve Foster Trust, for an essay on "Zinc, its Production and Industrial Applications," has been awarded by the Council to Mr. J. C. Moulden, A.R.S.M., M.Inst.M.M., of Seaton Carew, Co. Durham. Honourable mention has also been awarded to Mr. Ernest Alfred Smith, A.R.S.M., M.Inst.M.M., Deputy Assay Master of the Sheffield Assay Office, for his essay.

The adjudicators, on whose recommendation the award was made, reported that the two essays above mentioned were distinctly superior to the others, several of which, nevertheless, were of interest and value. An essay by Mr. Ramji Das Vaishya, of Gwalior, Central India, contained a good deal of information with regard to the production and utilisation of the metal in the East Indies.

The prize essay will be read in abstract at one of the meetings of the Society after Easter.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1916 early in May next, and they therefore invite members of the Society to forward to the Secretary on or before Saturday, March 25th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded in previous years as follows;—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, etc., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.,

"for services rendered to Arts, Manufactures, and Commerce by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the Department of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvements in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential services in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious manual labour."

In 1879, to Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labour in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silkworms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of our several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (afterwards Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (afterwards Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry—the utilisation of waste silk."

In 1887, to HER MAJESTY QUEEN VICTORIA, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value of his researches in various branches of science, and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for his achievements in promoting the Arts, Manufactures, and Commerce through the world-wide influence which his researches and writings have had upon the progress of the science and practice of metallurgy."

In 1890, to Dr. (afterwards Sir) William Henry Perkin, F.R.S., "for his discovery of the method of obtaining colouring matter from coal tar—a discovery which led to the establishment of a new and important industry, and to the utilisation of large quantities of a previously worthless material."

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S., "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures, by the application of Chemical Science, and especially by his researches in the manufacture of iron and of steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

In 1892, to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy, in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S., "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted."

In 1894, to Sir Joseph (afterwards Lord) Lister, F.R.S., "for the discovery and establishment of the antiseptic method of treating wounds and injuries, by which not only has the art of surgery been greatly promoted, and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his metallurgical researches and the resulting development of the iron and steel industries."

In 1896, to Professor David Edward Hughes, F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone."

In 1897, to George James Symons, F.R.S., "for the services he has rendered to the United Kingdom by affording to engineers engaged in the water-supply and the sewerage of towns a trustworthy basis for their work, by establishing and carrying on during nearly forty years' systematic observations (now at over 3,000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself."

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S., "in recognition of his numerous and most valuable applications of Chemistry and Physics to the Arts and to Manufactures."

In 1899, to Sir William Crookes, O.M., F.R.S., "for his extensive and laborious researches in chemistry and in physics—researches which have, in many instances, developed into useful practical applications in the Arts and Manufactures."

In 1900, to Henry Wilde, F.R.S., "for the discovery and practical demonstration of the indefinite increase of the magnetic and electric forces from quantities indefinitely small—a discovery now used in all dynamo machines—and for its application to the production of the electric searchlight, and to the electro-deposition of metals from their solutions."

In 1901, to His Majesty King Edward VII., "in recognition of the aid rendered by His Majesty to Arts, Manufactures, and Commerce during thirty-eight years' Presidency of the Society of Arts, by undertaking the direction of important exhibitions in this country, and the executive control of British representation at International Exhibitions abroad, and also by many other services to the cause of British Industry."

In 1902, to Professor Alexander Graham Bell, "for his invention of the telephone."

In 1903, to Sir Charles Augustus Hartley, K.C.M.G., "in recognition of his services, extending over forty-four years, as Engineer to the International Commission of the Danube, which have resulted in the opening up of the navigation of that river to ships of all nations, and of his similar services, extending over twenty years, as British Commissioner on the International Technical Commission of the Suez Canal."

In 1904, to Walter Crane, "in recognition of the services he has rendered to Art and Industry by awakening popular interest in Decorative Art and Craftsmanship, and by promoting the recognition of English Art in the form most material to the commercial prosperity of the country."

In 1905, to Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S., "in recognition of the influence which his researches, directed to the increase of scientific knowledge, have had upon industrial progress, by facilitating, amongst other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for sound signalling at sea."

In 1906, to Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S., "for the important part he took in the invention of the incandescent electric lamp, and for his invention of the carbon process of photographic printing."

In 1907, to the Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E., "in recognition of his pre-eminent public services in Egypt, where he has imparted security to the relations of this country with the East, has established justice, restored order and prosperity, and, by the initiation of great works, has opened up new fields for enterprise."

In 1908, to Sir James Dewar, M.A., D.Sc., LL.D., F.R.S., "for his investigations into the liquefaction of gases and the properties of matter at low temperatures—investigations which have resulted in the production of the lowest temperatures yet reached, the use of vacuum vessels for thermal isolation, and the application of cooled charcoal to the separation of gaseous mixtures and to the production of high vacua."

In 1909, to Sir Andrew Noble, K.C.B., D.Sc., D.C.L., F.R.S., "in recognition of his long-continued and valuable researches into the nature and action of explosives, which have resulted in the great development and improvement of modern ordnance."

In 1910, to Madame Curie, "for the discovery of radium."

In 1911, to the Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S., "for his experimental researches into the laws governing the efficient action of steam in engines of the turbine type, and for his invention of the re-action type of steam turbine, and its practical application to the generation of electricity and other purposes."

In 1912, to the Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., G.C.V.O., LL.D., D.C.L., F.R.S., "for his services in improving the railway communications, developing the resources, and promoting the commerce and industry of Canada and other parts of the British Empire."

In 1913, to His Majesty King George V., "in respectful recognition of His Majesty's untiring efforts to make himself personally acquainted with the social and economical conditions of the various parts of his Dominions, and to promote the progress of the Arts, Manufactures, and Commerce in the United Kingdom and throughout the British Empire."

In 1914, to Chevalier Guglielmo Marconi, LL.D., D.Sc., "for his services in the development and practical application of wireless telegraphy."

In 1915, to Professor Sir Joseph John Thomson, O.M., D.Sc., LL.D., F.R.S., "for his researches in physics and chemistry, and their application to the advancement of Arts, Manufactures, and Commerce."

PROCEEDINGS OF THE SOCIETY.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 8th, 1916; Richard T. Glazebrook, C.B., M.A., D.Sc., F.R.S., Director of the National Physical Laboratory, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Middleton, Austin R., Baltimore, Maryland, U.S.A.

Patel, J. M. Framjee, J.P., Cumballa Hill, Bombay, India.

Starr, William J., LL.B., Eau Claire, Wisconsin, U.S.A.

The following candidates were balloted for and duly elected Fellows of the Society:—

Jeejeebhoy, Merwanjee D. M., 78, Apollo-street, Fort, Bombay, India.

Mukerji, B. K., Lashkar, Gwalior, India.

Oliphant, Professor Samuel Grant, A.M., Ph.D., Grove City College, Grove City, Pennsylvania, U.S.A.

The paper read was—

OPTICAL APPLIANCES IN WARFARE.

By Charles R. Darling, A.R.C.Sc.I., F.I.C.

In a lecture delivered to a military audience in 1865, John Ruskin made use of the following sentence: "There is no form of science which a soldier may not at some time or other find bearing on business of life and death." The truth of this utterance has been fully borne out in the present conflict, in which all the resources of science are being utilised for one or other end. It will not be out of place, therefore, to lay before the Society an account —necessarily incomplete in the compass of a single paper—of the application of one branch of science, that of Optics, to modern warfare.

In dealing with the optical appliances used in the field, which comprise a large number of separate items, it is not possible to give a detailed account of each, as a whole paper might be devoted to a single class of instruments, such as range-finders. In the present paper, therefore, it is intended to take a general survey of the whole subject, so as to convey an idea of the nature of the optical instruments used and the purposes they fulfil.

The following are the chief optical appliances used in warfare:—

1. Field-glasses and telescopes.
2. Searchlights.
3. Periscopes.
4. Range-finders.
5. Signalling lamps and heliographs.

In addition to the above, cameras, prismatic compasses, surveying instruments, etc., are used; but it is only proposed in the present paper to deal with appliances specially devoted to warfare, and embraced in the above five headings, which will be treated in turn.

Field-Glasses and Telescopes.

As an aid to vision, field-glasses or telescopes are essential in military operations, and a number of different patterns, varying according to circumstances, are in use. Binoculars on the principle of the Galilean telescope possess several drawbacks as compared with modern prismatic glasses, notably that the field of view is small and the magnification low, and also that cross-wires cannot be introduced, owing to the fact that no real image of the object is

produced. On the other hand, they give good illumination, and in a dull or dark atmosphere may be used to advantage. Patterns with magnifying powers of three, four and five respectively are in use, having fields of view ranging from about 3° to 4° 30′.

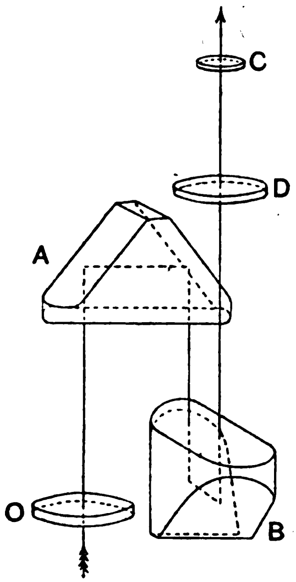

FIG. 1.

The prismatic binoculars introduced by the firm of Zeiss have the advantages: (1) That a long-focus object-glass may be used in a short body; (2) an increased field of view is obtained, with greater stereoscopic power, by placing the object-glasses further apart than the eyepieces; and (3) a real image of the object is formed, enabling cross-wires or graticules to be used. The path of the central ray through one side is shown in Fig. 1. The object-glass O, in the absence of prisms, would form an inverted image of the object; but in passing through the prism A the image is reversed from left to right, and in B, which is placed at right angles to A, the image is reversed vertically, an erect image thus being formed in the focal plane of the eyepiece, which is composed of two lenses, C and D, which magnify the image without inversion. In effect, this arrangement is equivalent to an ordinary telescope, of length equal to the path of the central ray; and as the magnifying power is equal to

$$\frac{\text{Focal length of object-glass}}{\text{Focal length of eyepiece,}}$$

it is evident that a great advantage is gained by lengthening the path of the ray and increasing the focal length of the eyepiece. Patterns are issued with magnifying powers of six and eight, and with fields of view ranging from 4° 30′ to about 8° 30′, figures which show a marked advantage over the Galilean type. In some of these graticules are fitted in the focal plane of the object-glass. These consist of a number of lines ruled on a glass plate, spaced out so as to represent minutes of deflection to right and left, as shown in Fig. 2, which assist in accurately determining the position of an object in the field of view. If rotated through a right angle, the graticules may be used similarly for elevated objects, the dimensions of which may thus be estimated.

A number of different kinds of telescopes, fitted with special devices, are used either for general observations, or as distinctive parts of instruments, such as directors or gun-sights, the magnifying power ranging from three to thirty-five. In some patterns the magnification may be varied over a large range—from five to twenty diameters—by a single movement, without disturbing the focus of the sighted object. This is accomplished, in the Ross pattern, by moving the erecting lens further away from the eyepiece, that is, nearer to the image formed by the object-glass. The size of the upright image, viewed by the eyepiece, is thereby increased, and the final image is correspondingly magnified. If the erecting lens alone were altered in position, the object would no longer be in focus; but by means of a mechanical device the eyepiece is made to move simultaneously by the amount necessary to retain the focus. The advantage of a variable power telescope is that the low power may be used as finder, whilst the high power can be

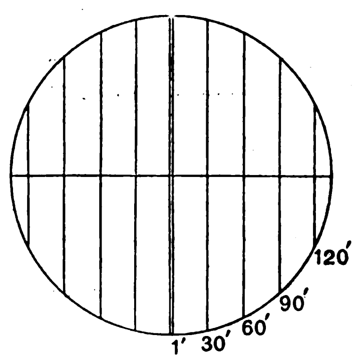

FIG. 2.

brought in for better definition without changing the focus. The initial adjustment is carried out by means of a movement independent of that which produces the change of power.

When telescopes are used as gun-sights, a pointer, or sighting-wire, is placed in the focal

plane of the object-glass, where the image of the target will be formed, and when the image is seen to coincide with the assigned mark the aim is correct. This method of sighting is preferable to the alignment of the target with a fore-sight and back-sight, as in this case the eye cannot be focussed for all three points at once, and a greater or less degree of uncertainty results; whereas with a telescopic sight both target and auxiliary mark are in focus at the same time. Telescopic sights have also been applied to rifles, a similar advantage being gained. When a telescopic sight is used at night it is necessary to illuminate the lines or pointer, and this is usually accomplished by means of a small electric lamp inserted in a suitable position in the telescope.

For observing the effect of artillery fire, the stereo-telescope, also due to the firm of Zeiss, is much used, as its stereoscopic power enables a much better judgment of distances to be formed than in the case of an ordinary telescope. This instrument is a binocular with hinged tubes, which may be moved to any desired angle between the vertical and horizontal, the stereoscopic power increasing as the distance between the object-glasses becomes greater. Rays from the object enter each tube by a window, in front of which is a prism which reflects the light on to the object-glass, and by means of two prisms at right angles the rays are brought into the eyepiece. This telescope may be used with the tubes at any angle, or an object may be sighted over a wall or parapet without exposing the observer. One pattern in common use has a magnifying power of ten diameters, with a field of view of 4°, and has one eyepiece fitted with a graticuled diaphragm, which may be used horizontally or vertically, for accurate observation of positions.

Searchlights.

The searchlight does not play a prominent part in land warfare under present conditions, as it would be too conspicuous an object, and when illumination is required star-shells are used. As a means of sighting air craft, for coast defence, and for naval purposes, however, the searchlight is indispensable. The source of light is an electric arc, fed by clockwork, which is placed at the focus of a concave mirror. This mirror forms the end of a tube out of which the reflected rays are projected, and which is mounted on a base so as to be capable of horizontal or vertical movement. As the focus of a mirror is a point, it is evident that only one point of the crater of the arc can occupy this position, and rays emanating from this point, after reflexion, will proceed in lines parallel to the axis of the mirror. From all other portions of the crater, however, the rays will be reflected from the mirror at an angle to the axis, the value of which, under working conditions, is 2° or 3°. Hence the beam as a whole is divergent, and lights up a much larger area than that of the mirror itself; whereas, if all the rays were parallel the illuminated area would only be equal to that of the mirror. At a distance of 2,000 yards the illuminated area, owing to this divergence, usually has a diameter of 100 yards, and enables objects comprised in this area to be clearly seen. The shape of the mirror or reflector is a matter of the greatest importance if a satisfactory beam is to be obtained. A spherical surface, owing to

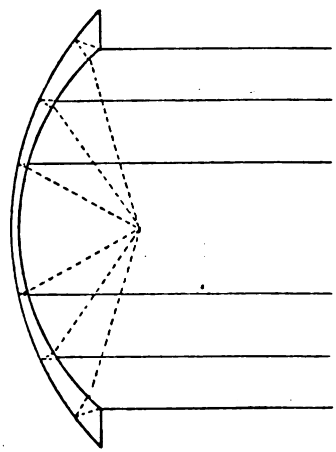

FIG. 3.

the aberration produced by the edges, is not suitable. In the reflector invented by Colonel Mangin, of the French Engineers (Fig. 3), this difficulty was overcome by the use of a glass mirror, silvered at the back, the front face possessing a greater curvature than the outer face, so that the reflector was thicker at the edges than at the centre. The rays, being more refracted at the edges, were thus made to escape in a direction parallel to the axis when emanating from the focus, thus correcting for aberration. These reflectors gave an excellent beam, but being made of glass were liable to breakage, either in transport or due to the heat of the arc, and have now been almost entirely superseded. For ordinary working paraboloid mirrors, made of metal, are now used, the reflecting surface being of silver or gold, or occasionally palladium or nickel. When it is desired to light up a large area at short range, the mirror used is parabolic

in vertical section and elliptical in horizontal section; the focus of the parabola coinciding with one of the foci of the ellipse. As all rays emanating from one focus of an ellipse pass after reflection through the other focus, the beam spreads out horizontally, but retains its normal dimensions vertically owing to the parabolic section. The amount of lateral dispersion produced in this manner may be as much as 45°, and hence a large area may be illuminated. An alternative method of producing a diverging beam is to place a number of positive cylindrical lenses in the path of the beam side by side, each of which brings the rays from a portion of the mirror to a focus on a line beyond the lens, from which the rays afterwards diverge. By using two rows of lenses, that nearest the mirror being fixed whilst the outer row is movable, any desired degree of dispersion may be secured. This form is generally used for naval purposes, and has the advantage of enabling one form of beam to be adapted to all conditions. The diameters of the reflectors used range from 120 cms. (nearly 4 ft.) to 35 cms. (14 in.); and the focal lengths from 65 cms. (25·5 in.) to 15 cms. (6 in.).

The carbons used for the arc vary in size, according to the current used, and are placed horizontally. The positive carbon, in which the crater is formed, faces the mirror, and is made of larger diameter than the negative, and is provided with a graphite core in order to keep the crater central. The smaller size of the negative carbon results in less obstruction of the light from the crater. The diameter of the crater ranges from 9 mm. in a 20-ampere lamp to 23 mm. in a lamp taking 150 amperes, the diameters of the positive and negative carbons being 18 mm. and 12 mm. respectively in the former case, and 38 mm. and 26·5 mm. in the latter.

There are many optical principles involved in the structure of a searchlight beam which cannot be entered into in detail in a paper of this description, and accordingly only conclusions will be given. Each point on the mirror reflects the image of the crater, and sends out a cone of light; the cones emanating from the central part having nearly circular bases, whilst those reflected from the edges have elliptical bases, as the projection of the crater on these portions is an ellipse. The resultant beam is a blending of these cones, and consists of an evenly-illuminated centre, round which the brightness diminishes to zero at the edges. The cones from the central portion of the mirror have dark centres, owing to the negative carbon shutting off some of the light of the crater, and the reflected light from the edges also possesses a dark portion, though not central, due to the same cause. All these points may be noted on looking at the projection of a searchlight beam on the clouds.

The following laws hold good for the beam:—

1. The diameter of the illuminated area is proportional to the diameter of the crater.

2. The diameter of the illuminated area is independent of the area of the mirror.

3. The diameter of the illuminated area is inversely proportional to the focal length of the mirror.

4. The diameter of the illuminated area is directly proportional to the distance from the projector.

5. The intensity of illumination is independent of the size of the crater, and of the focal length of the mirror.

6. The intensity of illumination is directly proportional to the area of the mirror, and inversely proportional to the square of the distance from the projector.

From these laws it may be gathered that the greater the area to be illuminated, the larger must be the diameters of the mirror and crater.

In order to secure a steady light, the voltage at the lamp terminals must be kept constant. A 90-ampere arc, for example, requires 56 volts, and the supply voltage must be reduced to and kept at this figure by the use of a series resistance. The carbons should be homogeneous, so as to secure a crater of unvarying shape, and should be correctly aligned. The management of a searchlight demands considerable skill, and the large number used for home defence has entailed a demand for operators with electrical knowledge, which, fortunately, our technical colleges have been able to meet.

Periscopes.

The common article sold at many shops for use in the trenches, and consisting of two mirrors mounted in a frame and inclined at 45°, is an old invention which used to be called the "polemoscope," but is now wrongly termed a periscope. Strictly speaking, a periscope is an instrument in which the whole surroundings of an observer may be viewed through a fixed eye-piece. For naval work, and particularly for submarines, these instruments are invaluable, as observations may be made with nothing but the top of the instrument projecting above the water. A periscopic gun-sight also enables guns to be laid behind cover, and enables auxiliary marks to be used without the gunner having to

change his position. The principle of the periscope is shown in Fig. 4, in which the path of the central ray is indicated. The upper prism A is mounted on a cowl, so as to be

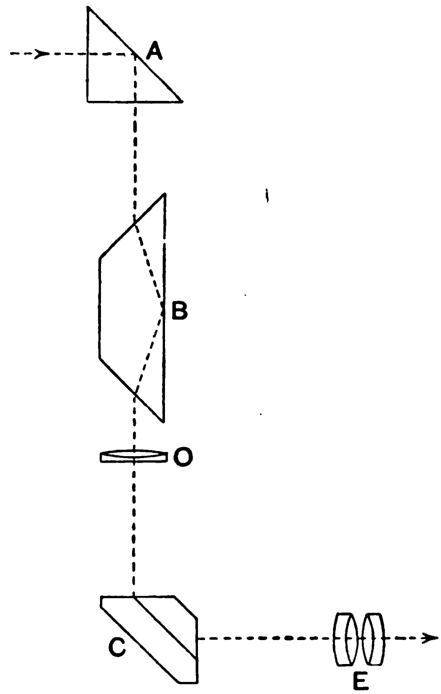

Fig. 4.

capable of revolution in a circle. Rays from the object are reflected from its sloping face into a second prism B, the longer vertical face of which acts as reflector. The rays then pass through the object-glass O, and thence through a third prism C, known as a "roof" prism, which turns the rays at right angles into the eyepiece E. The prism A inverts the rays vertically, but by passing through B, which also inverts vertically, this effect in A is counteracted and an upright image enters the object-glass O. This lens inverts the rays both horizontally and vertically, but the prism C, in which two reflexions occur, restores the rays to the original directions, and hence a correct image is viewed by the eyepiece, which magnifies without causing inversion in either direction. When the prism A is revolved, B is caused by an attached mechanism to move at one half the rate, and as the angular movement of a ray is twice that of the mirror which produces it, the rays will always fall on the object-glass in the same direction, whatever may be the position of A. The upper prism may be placed at the end of a tube at any desired height above the observer.

Many modifications of the above arrangement exist in periscopes of different makes; the general principle, however, is the same.

Range-Finders.

The first range-finder of which I have been able to discover a record was designed by James Peacock, architect, of Finsbury Square, and published in a book entitled "A Repertory of Arts, Manufactures and Inventions" in 1794. This range-finder is interesting from the fact that it is a "one-man" instrument, with a short base, relying for its accuracy on optical perfection—resembling in this respect the most recent instruments. The principle is indicated in Fig. 5, where AG is a scale to one end of which is fixed a flat mirror F, inclined at 45° to the edge of the scale. A telescope T is fixed at right angles to the lower edge, so that its cross-wire is exactly opposite the end. At the other extremity of the scale is placed a second flat mirror E, fixed at a definite angle, but capable of horizontal motion along the scale. In marking the scale to read ranges, it was proposed to light a candle at one end of General Roy's five-mile base and to view the light through the telescope from the other end of the base, the upper portion of F being left unsilvered for this purpose. The mirror E was then to be tilted so that the reflected image, after falling on the silvered part

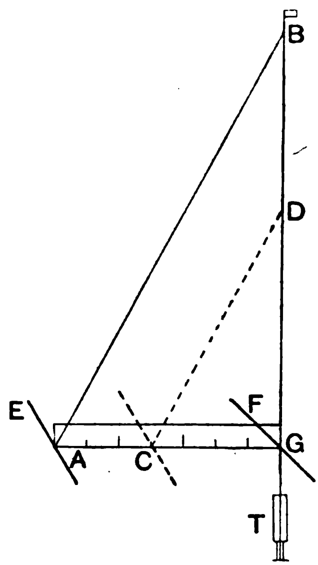

Fig. 5.

of F and passing into the telescope, was exactly in line with the direct image, in which position it was to be securely fastened so as to retain its inclination. The extremity of the scale A was

then to be marked five miles, and G zero, the part in between being divided into equal divisions of any desired size. The range could then be read off directly by observing the position of E when the images coincided; thus the range GD would be represented by CG on the scale, since $\frac{GD}{GB} = \frac{CG}{AB}$. It was suggested that the instrument would be useful to surveyors—in those days the accurate, long-range gun had not been invented—but there is no mention of its actual manufacture. The idea, however, is sound; and with modern appliances might probably be worked up into a satisfactory range-finder.

In the demand for range-finders, caused by modern guns, the instruments at first used—and not yet entirely extinct—required two observers, and a long base was adopted with a view to accuracy. The service "mekometer" (Fig. 6) is an example of this type. An observer

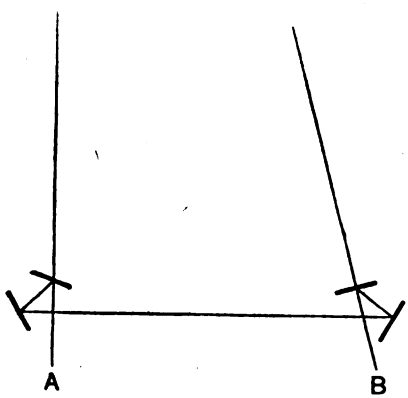

Fig. 6.

stationed at A uses an instrument containing two mirrors inclined at 45° to each other, the upper mirror being unsilvered in its upper portion. On looking at this mirror he sees the target through the upper part directly, and, by reflexion, a white mark on the instrument of the second observer. When target and mark appear in line, the base is at right angles to the target. The observer at B uses a similar instrument, except that the lower mirror may be moved by a milled-head, which must be turned until the target coincides with the white mark on the instrument at A. The angle could then be determined and the triangle solved; but to save calculation the range is marked directly on a drum which rotates with the milled-head. The base used is 25 or 50 yards long, according to pattern, and consists of a stout cord with hooks at the end to fasten to the instruments. Simple as the mekometer seems, it is not easy to obtain very accurate results by its use. The cord cannot be pulled perfectly straight, and variations in the amount of droop alter the result. Small errors in aligning the target and the white mark also cause notable errors in the reading, and it is not uncommon for beginners to return results varying by 20 per cent., even when using the same instruments and target. Two skilled observers, however, using a 50-yards base-cord, should take a range of 2,500 yards with an error not exceeding 2 per cent.

The "Field Telemeter" consists of a single instrument, but requires two men to use it in taking a range. It differs from the mekometer in the respect that a base of any suitable length may be used. The actual length of the base chosen for the occasion is measured by the instrument, the standard of reference being a steel tape 6 or 9 yards long, according to the pattern. This tape is run out at right angles to the base at one end, and serves as a sub-base for the measurement of the working base. A sliding collar, moving over a graduated bar, is then set at the figure corresponding to the measured base, the position of this collar determining the amount of angular movement imparted to the movable mirror by the adjusting-screw. The range is read off from a drum which rotates with the adjusting-screw; and whatever length of base be chosen, the same figure will be obtained, provided the sliding collar be correctly set on the bar. A detailed description of this instrument would not be possible within the limits of the present paper. It may be stated, however, that the field telemeter is superior to the mekometer, particularly for long ranges; and practised observers can obtain readings up to 5,000 yards with an error not greater than 2 per cent. The Watkin Field Range-Finder is a similar instrument.

All range-finders requiring two observers and the setting out of a base-line suffer from the defects, (1) that a considerable time—possibly five minutes—is required to obtain the range; and (2) that the ranges of moving objects cannot be taken continuously. For these reasons, both for naval and military use, "one-man" range-finders are found preferable. The type introduced by Professors Barr and Stroud is now generally employed, and gives very satisfactory results, although its construction is more delicate than that of "two-men" instruments.

Fig. 7 indicates the arrangement of parts in the Barr and Stroud range-finder, which consists of two telescopes with a single eyepiece. Rays from the distant object enter the five-sided prism A through a window, and as the sides of this prism are inclined at 45° the emerging ray escapes at right angles to its original path and passes through the objective O to the central reflecting prisms R, from whence it enters the eyepiece E. The rays entering the right-hand prism B follow a similar course through the objective; but, owing to the length of the tube, such rays will enter B at a different angle to which rays from the same point enter A, and will pass through the tube inclined to the horizontal. This inclination will evidently vary with the distance of the sighted object; and, if the rays were permitted to pass unchanged to the central reflectors, and so to the eyepiece, the image of the object would not coincide with that formed by the system on the left. By interposing an adjusting-prism P in the path of the inclined rays, however, they may be turned into a horizontal position, when coincidence of the images will occur. The correct position of P depends upon the inclination of the rays which enter it—that is, upon the distance of the target; and hence this position may be used to define the range by attaching a range scale S to P, and noting the reading opposite a fixed point.

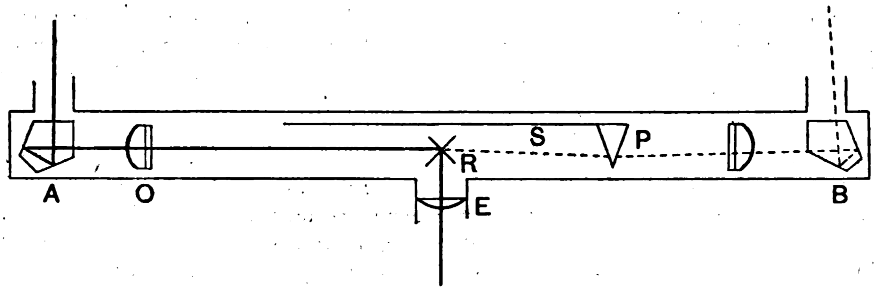

FIG. 7.

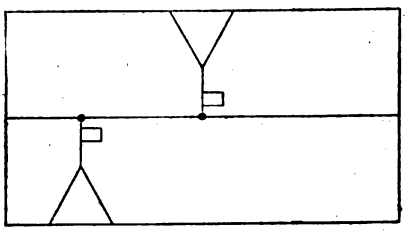

FIG. 8.

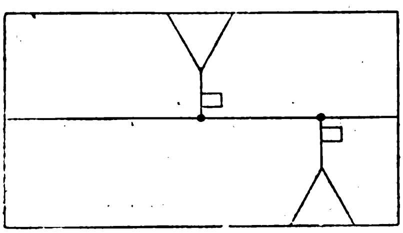

FIG. 9.

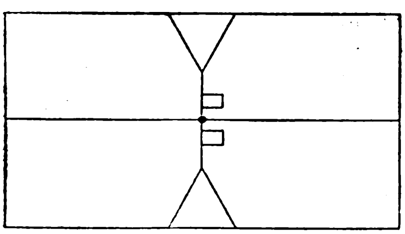

FIG. 10.

The method of obtaining coincidence is indicated in Figs. 8, 9, and 10. The arrangement of the central prisms is such that the image due to the left-hand telescope is inverted, whilst that formed by the right-hand side is erect, both being seen in the eyepiece divided by a central line. In Fig. 8 the adjusting prism is too near the centre, and gives an image displaced to the left; in Fig. 9 it is too far away from the centre, the image now being too far to the right; whilst Fig. 10 shows the correct position, the images being coincident. In the actual instrument, a second lens is provided near the eyepiece, through which the range may be viewed simultaneously with the image. The following are some particulars of the instrument: Total length, 44½ in.; working base, 1 metre; weight, 13½lb.; magnification of telescope, 13; field of view, horizontal, 3° 10′; field of view, vertical, 2° 40′; range scale graduated from 500 to 20,000 yards; accuracy, 2½ per cent. at 5,000 yards. Readings at the highest ranges are only approximations. General experience with the Barr and Stroud range-finder is entirely in its favour, and shows it to be superior to the types which require two observers.

The Zeiss range-finder differs from the Barr

and Stroud in the construction of the adjusting-prism, which, in the Zeiss pattern, consists of two wedges of glass rotated in opposite directions by a gearing, the deviation of the ray being thereby changed as desired. The same movement actuates the range-scale in front of a fixed pointer, opposite which the range is read off after adjustment. This gives a small total length of scale, and in this respect is inferior to the Barr and Stroud.

In the Marindin range-finder the five-sided prisms are replaced by right-angled prisms, which carry the object-glasses on their upper surfaces, facing the target. Each reflects the image from its hypotenuse to the central prisms, from whence they pass into the eyepiece. Adjustment to coincidence is obtained by turning a drum on which the scale is marked, and which at its forward end engages a lever fastened to the right-hand prism, which is thereby tilted and alters the position of the image in the eyepiece. The range is read directly from the drum. This instrument, used by infantry, reads up to 8,000 yards, the error at 2,000 yards not exceeding 5 per cent.

The Zeiss stereo-telemeter depends on stereoscopic vision, and has been used to some extent in our own Army as well as the German. A pair of transparent plates are placed in a binocular, one in each eyepiece, forming a stereoscopic couple. On these plates are marked arrows pointing downwards in three zig-zag lines. Each corresponding pair gives a single image in relief, and as no two pairs are the same distance apart, the appearance presented is that of a number of arrows overhanging the landscape at progressive distances from the eye. In taking a range, the observer must decide which of the arrows overhangs the target; the distance is then taken as that marked against this arrow. The arrows are marked from 90 to 3,000 metres; but the accuracy depends upon the eyesight of the observer, which should be good and equal in both eyes—a condition which reduces the number of reliable operators to about 20 per cent. of an average body of men. If this condition be fulfilled, the error will not exceed 1 per cent. at 1,000 yards, or 4 per cent. at 5,000 yards.

Signalling Devices.

In trench warfare signalling by flags, heliograph, or lamps is not greatly resorted to, the field telephone being better adapted for communications under these conditions. In open warfare, however, the heliograph is useful for flashing signals by the aid of sunlight. It consists of a circular flat mirror, 5 in. in diameter, capable of being tilted through a small angle by means of a key, and possessing a sighting-vane for laying on to the receiving station. The Morse code is used, short flashes representing dots, and a sustained flash dashes. For night work signalling lamps are used, a parallel beam of light being sent out, which can be cut off by a movable shutter. Some lamps burn oil, others acetylene, and a strong lens is used to produce the parallel beam.

Conclusion.

It is evident from the foregoing descriptions that optical devices, often of a type which requires great precision in the making, play an important part in modern warfare. An unforseen demand for these instruments has arisen and it is gratifying to know that our opticians are responding well to the call. The steps that have been taken to secure an adequate supply of the right kind of glass were described recently by Dr. Rosenhain in his Cantor Lectures before this Society. We have allowed Germany to get a long way ahead of us in some respects in relation to optical appliances, and for a simple reason. In Germany manufacturers and men of the highest scientific attainments have co-operated; in this country they have not. The commercial realisation of an idea is quite a different matter to its mere inception; and unless our best scientific men are willing to give some of their time to production, and not confine themselves to research in so-called "pure" science, there is little hope of improvement in the future. Manufacturers have received plenty of advice but no practical help in the past. A step in the right direction would be greatly to extend the scope and activities of the National Physical Laboratory, so as to enable it to assist in problems of production in the case of industries of a highly scientific character, of which optical appliances form a characteristic example.

Another matter, referring to recent conditions, will be obvious. Every officer who may be called upon to use scientific instruments should receive a scientific training to enable him to use them properly. For many years past it has not been deemed necessary to impart a knowledge of science to infantry and cavalry officers, so that it became a tradition that science was only of use to the "sapper" and the "gunner." Experience in the present war has proved that every officer, whatever branch of the Service he may belong to, would be able to serve his country better if he received a training in science.

Using instruments according to drill regulations only is of very limited service; for in the presence of a small defect which could easily be remedied by one who understands an instrument, the mere automaton would be helpless. On the occasion of a lecture on "Field Telephones," delivered before the Society in July last, I appealed for the services of science teachers to be utilised in teaching that subject, and since that time much useful work has been done and is still in progress. I would extend that appeal so as to include all branches of military science that may be taught successfully at a college or technical school. Advantage could be taken of the buildings and equipment, and members of the staffs would be found willing to devote any spare time to the work. Taking the instruments described in the present paper as typical, a few experimental lessons would suffice to give intelligent men an insight into the working which could never be obtained by mere drill, and co-operative action on these lines between the military and educational authorities could not fail to increase the efficiency of our Army.

[Examples of modern optical appliances for naval and military purposes were exhibited by Messrs. Ross, Ltd., and by Messrs. R. & J. Beck, Ltd.]

DISCUSSION.

THE CHAIRMAN (Dr. R. T. Glazebrook) said the audience would agree that the author was to be congratulated on the manner in which he had been able to describe the principles of the working of optical apparatus, which was now of fundamental importance in the war. It was of advantage that everyone should realise and appreciate the difficulties that had had to be overcome by the direct applications of optical science and other branches of science. There was no doubt whatever as to the importance of the matter dealt with, and as to the necessity for everyone interested to combine to render the instruments even more perfect and more satisfactory than they were at present. With regard to the original form of range-finder, he would suggest that if any members of the audience were interested in instruments of that kind they would find a great deal of very valuable and useful information in a little pamphlet recently republished by Mr. Cheshire, of the Ministry of Munitions. With regard to instruments generally, he could cordially substantiate all the author had said about the excellence of the quality of the instruments that were now being made for the Services. Many of the instruments for the Navy passed through his own hands, and he had sometimes to deal with other instruments, and there was no doubt whatever that they were now of a very high degree of perfection, and a debt of gratitude was owing to English optical instrument-makers for the care and attention they had devoted to the work. At the same time, he could not help thinking there was a somewhat sad history attached to many of them. Reading the paper, it would be seen that in too many cases the author began with a simple instrument, an excellent instrument of its time, of English manufacture, and, after tracing the development of that instrument, nearly always ended up with a German name. One striking exception to that rule was the Barr and Stroud range-finder, which was of English invention and English manufacture; but even then the author passed from the Barr and Stroud to a special form of Zeiss instrument. It was to be hoped that one of the results that would follow from a consideration of the subject after the war would be the careful thought and careful development by instrument-makers of the theory of the instruments they were making and of the principles that underlay the theory. He wished it were possible to see established in London an institution for which he, amongst others, had pleaded for many years past, devoted to the teaching of higher optics as applied to instruments of all kinds, but especially as applied to instruments of war, teaching that would include not only the theory of the instruments but the practical details of their manufacture. Such an institution was most urgently needed, and it would be a crying shame if, within the near future, it was not established in London on a satisfactory and lasting basis.

MR. F. CHESHIRE said as far as he was aware the first practical range-finder was one that was invented in the latter half of the eighteenth century by a German named Brander. The instrument was well designed and capable of reliable work. He was pleased to say that at the present time the Barr and Stroud range-finder for field use was, in his opinion, the best in the world. On the Continent it had beaten the range-finders made by the best German makers. The accuracy of the instrument, taking into consideration the conditions under which it was used, was phenomenal. The author, in referring to the prismatic binocular, stated that one great advantage of the instrument was that it allowed the use of an objective of great focal length. When the prismatic binocular was introduced it was almost impossible to obtain ordinary terrestrial telescopes with a smaller magnification than fifteen. Galilean binoculars, on the other hand, could not be made efficient with a greater magnification than about five. The great merit of the prismatic binocular was that it filled up the gap between the opera-glass and the ordinary terrestrial telescope—that is, it gave magnifications between five and fifteen. Previous to the introduction of the prismatic binocular many attempts had been made to couple together two

ordinary terrestrial telescopes to obtain a binocular instrument, but these attempts had failed largely because it was found impossible to secure and maintain the necessary order of accuracy of the parallelism of the axes of the two telescopes. The prismatic binocular being a much shorter instrument enabled a hinged connection to be made which was efficient in maintaining the necessary parallelism of the axes. With regard to the author's mention of a telescope which had the magnifying power of one when looked through in one direction and a magnifying power of three when looked through in the other direction, he thought that some mistake had been made. If Mr. Beck had really made such a telescope he had certainly not submitted it to the Ministry of Munitions. So far, all telescopes that he had any acquaintance with had a magnifying power when looked through in one direction which was the reciprocal of that obtained by looking through it in the other.

MR. CHARLES DARLING said the instrument he had referred to was not a telescope but a periscope, and he understood it was so arranged that it was possible to get a direct view unmagnified by looking through one window and a three-time magnification by looking through another window.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to the author for his paper, and the meeting terminated.

CORRESPONDENCE.

A PIONEER IN AVIATION.

In your *Journal* of December 10th, 1915, No. 3290, Vol. LXIV., is published, under the heading "A Pioneer in Aviation," a biography of Lawrence Hargrave, Australia's pioneer of aviation.

I was very pleased to find this eulogium of so fine a worker in the field of applied science, and I would like to thank you for its insertion.

Now, it may interest your readers to know that in this museum are housed, in a very large plate-glass showcase—the largest in the museum—a complete series of Hargrave's original models of his monoplanes, those used to illustrate his papers read before our Royal Society on flying machines.

I notice you state "It is not to our credit that when, some years ago, Mr. Hargrave offered to hand over all his models to the Australian Government, so that they might be available for inspection by other inventors and the public generally, they could find no room for them anywhere. The same indifference was shown in England. So they were presented to Germany, and to-day they may be seen in the Deutsche Museum at Munich, and it is believed that the 'Taube' aeroplane, which has been so prominent in the war, is fashioned on one of these Australian models."

My object in writing is to point out that these remarks do not apply to the Government of New South Wales, for this museum's records show that in 1909 he offered to the Government of New South Wales, through the Premier, his models of box kites, leading up to his biplane machines. His offer was submitted to me, and I recommended the Government of that day to accept these particular models, and so make the series of his inventions complete in this museum. The Minister for Public Instruction also recommended their acceptance, and an excerpt from the Premier's final minute states: "Accommodation will be found in the Technological Museum." I do not think they were offered to any other Australian Government.

I always regretted Lawrence Hargrave's action in this matter, and I am afraid a writer at the time accounted for his death in the words: "But I know that the German bullet that killed his only son, killed Lawrence Hargrave."

RICHARD T. BAKER,
Curator.

The Technological Museum,
Harris Street, Sydney.
January 25th, 1916.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

MARCH 15.—EDWARD PERCY STEBBING, F.L.S., F.R.G.S., Head of the Department of Forestry, University of Edinburgh, "Forestry and the War."

MARCH 22.—REV. P. H. DITCHFIELD, M.A., F.S.A., "The England of Shakespeare." HUBERT HALL, F.S.A. (Public Record Office), will preside.

MARCH 29.—R. W. SETON-WATSON, D.Litt., "Pan-German Aspirations in the Near East."

APRIL 5.—ARTHUR S. JENNINGS, "Painting by Dipping, Spraying, and other Mechanical Means."

MAY 3.—PROFESSOR W. B. BOTTOMLEY, M.A., F.C.S., F.L.S., "Bacterised Peat."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

APRIL 6.—PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India." THE RIGHT HON. LORD ISLINGTON, G.C.M.G., will preside.

APRIL 27.—JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

MAY 18.—SARDAR DALJIT SINGH, C.S.I., "The Sikhs."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m. :—

MARCH 28.—PERCY HURD, "Next Steps in Empire Partnership."

APRIL 11.—SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland." The Right Hon. SIR WILLIAM MACGREGOR, P.C., G.C.M.G., C.B., will preside.

Dates to be hereafter announced :—

JOHN COLLETT MOULDEN, A.R.S.M. M.Inst.M.M., "Zinc, its Production and Industrial Applications." (Peter Le Neve Foster Prize Essay.)

VICTOR HORTA, Directeur de l'Académie Royale des Beaux-Arts de la Ville de Bruxelles, "Belgian Architecture."

G. P. BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m. :—

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m. :—

EDWARD A. REEVES, F.R.A.S., F.R.G.S., Map Curator and Instructor in Surveying to the Royal Geographical Society, "Surveying, Past and Present." Three Lectures.

March 27, April 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 13 ... Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Hon. W. P. Reeves, "The Balkan States." (Lecture VI.)

Brewing Institute of (London Section), Imperial Hotel, Russell-square, W.C., 8 p.m. Mr. S. W. Cole, "The Cleansing of a Brewery."

TUESDAY, MARCH 14...Sociological Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.15 p.m. Mr. P. Mantoux, "The Influence of the War on the Problem of the Individual and the Social Factor in Historical Causation."

Colonial Institute, Hotel Cecil, Strand, W.C., 8.30 p.m. Mr. B. H. Morgan, "The Necessity for a Common Imperial Economic Policy."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Keith, "Sea Power as a Factor in the Evolution of Modern Races." (Lecture I.)

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 8 p.m. Mr. A. Wilcock, "Coloured and Patterned Draperies in Decoration."

Electrical Engineers, Institution of (Scottish Section), 207, Bath-street, Glasgow, 8 p.m. Dr. C. Chree, "Terrestrial Magnetism."

WEDNESDAY, MARCH 15... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Professor E. P. Stebbing, "Forestry and the War."

University of London, King's College, Strand, W.C., 5.15 p.m. Mr. L. B. Namier, "The Poles in their relation to Vienna and the Austrian Slavs."

Meteorological Society, at the Surveyors' Institution, 12, Great George-street, S.W., 7.30 p.m. Sir Napier Shaw, "The Meteorology of the Globe in 1911."

Electrical Engineers, Institution of (Local Section), The University, Birmingham, 7 p.m. Mr. N. W. Storer, "The Use of Continuous Current for Terminal and Trunk Line Electrification."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor W. L. Courtney, "Dramatists and War.—I. Aristophanes."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.30 p.m. Mr. W. G. Perkins, "Some Examples of Dangerous Structures."

THURSDAY, MARCH 16...Royal Society, Burlington House, W., 4.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. 1. The President, "Resemblance between African Butterflies of the genus *Charaxes*: a new form of Mimicry." 2. Mr. C. C. Lacaita, "Notes on Plants collected in Sikkim, including the Kalimpong District." 3. Mr. E. Bunyard, Exhibition of Species of *Ribes* and their garden derivation. 4. The General Secretary, "Early Botanical Exploration of North America."

Child Study Society, 90, Buckingham Palace-road, S.W., 6 p.m. Dr. E. Jones, "The Unconscious Mental Life of the Child."

Chemical Society, Burlington House, W., 8 p.m. 1. Mr. W. R. Innes, "Molecular association." 2. Mr. T. J. Drakeley, "The influence of iron pyrites on the oxidation of coal." 3. Mr. G. W. Hargreaves, "The essential oil of Cinnamomum Oliveri (Bail) or Brisbane Sassafras."

Royal Institution, Albemarle-street, W., 3 p.m. Professor H. E. Armstrong, "Organic Chemistry in War—Organic Products used as Propulsive and Explosive Agents." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. G. H. Rodman, "The Bernese Oberland."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Mr. N. W. Storer, "The Use of Direct Current for Terminal and Trunk Line Electrification."

Historical Society, 22, Russell-square, W.C., 5 p.m. Mr. J. F. Chance, "Germany in the Time of George I."

Numismatic Society, 22, Albemarle Street, W., 6 p.m. Mr. L. A. Lawrence, "More Chronology of the Short-Cross Period."

FRIDAY, MARCH 17 ... London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. A. Moor-Radford, "Kensington—Past and Present."

Royal Institution, Albemarle-street, W., 5 p.m. Dr. A. Strahan, "The Search for New Coal Fields in England."

University of London, at the London School of Economics and Political Science, Clare-market, W.C., 5 p.m. Mr. C. Turnor, "The Land and the Empire." (Lecture II.)

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Second Lieut. R. W. Fenning, "The Composition of the Exhaust from Liquid fuel Engines."

SATURDAY, MARCH 18...Royal Institution, Albemarle-street W., 3 p.m. Professor Sir J. J. Thomson, "Radiations from Atoms and Electrons." (Lecture II.)

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Journal of the Royal Society of Arts.

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FRIDAY, MARCH 17, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

Wednesday, March 22nd, 4.30 p.m. (Ordinary Meeting.) Rev. Peter Hampson Ditchfield, M.A., F.S.A., "The England of Shakespeare." Hubert Hall, F.S.A. (Public Record Office), will preside.

Further particulars of the Society's meetings will be found at the end of this number.

JOURNAL.

The Government limitations on the importation of paper and paper-making materials have rendered it necessary to restrict the *Journal* to the smallest possible size. For the present, therefore, its contents will be confined as far as possible to a report of the actual proceedings of the Society, and it may be necessary occasionally to publish reports of the meetings a little less promptly than has always been the practice.

It is hoped that the Fellows will appreciate the necessity of such restrictions, and it is also hoped that the *Journal* may be able to expand to its normal size at an early date.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1916 early in May next, and they therefore invite members of the Society to forward to the Secretary on or before Saturday, March 25th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, etc.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (afterwards Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (afterwards Lord Masham).

In 1887, to Her Majesty Queen Victoria.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to Dr. (afterwards Sir) William Henry Perkin, F.R.S.

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.

In 1892, to Thomas Alva Edison.

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

In 1894, to Sir Joseph (afterwards Lord) Lister, F.R.S.

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S.

In 1896, to Professor David Edward Hughes, F.R.S.

In 1897, to George James Symons, F.R.S.

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S.

In 1899, to Sir William Crookes, O.M., F.R.S.
In 1900, to Henry Wilde, F.R.S.
In 1901, to His Majesty King Edward VII.
In 1902, to Professor Alexander Graham Bell.
In 1903, to Sir Charles Augustus Hartley, K.C.M.G.
In 1904, to Walter Crane.
In 1905, to Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S.
In 1906, to Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S.
In 1907, to the Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E.
In 1908, to Sir James Dewar, M.A., D.Sc., LL.D., F.R.S.
In 1909, to Sir Andrew Noble, K.C.B., D.Sc., D.C.L., F.R.S.
In 1910, to Madame Curie.
In 1911, to the Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S.
In 1912, to the Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., G.C.V.O., LL.D., D.C.L., F.R.S.
In 1913, to His Majesty King George V.
In 1914, to Chevalier Guglielmo Marconi, G.C.V.O., LL.D., D.Sc.
In 1915, to Professor Sir Joseph John Thomson, O.M., D.Sc., LL.D., F.R.S.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 15th, 1916; John Slater, F.R.I.B.A., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Kewley, James, M.A., Cambrian Lodge, Portishead.
Walker, Basil Woodd, M.D., 6, Dawson-place, Pembridge-square, W.

The paper read was—

FORESTRY AND THE WAR.

By Edward Percy Stebbing, F.L.S., F.R.G.S.

It is not perhaps generally known that two and a half centuries ago, at the commencement of the reign of Charles II., this country was in a somewhat similar position, as regards afforestation and timber supplies, to the one existing at the present day.

At the period in our history to which I allude the devastating Civil War had but recently terminated. Great inroads into the existing forests had commenced after Henry VIII. had taken possession of the Church lands and converted them, together with their woods, to his own use. But at that time the whole kingdom was well wooded and the forests were not seriously impaired. During the Civil War, however, both the Royal Forests and those of the landed proprietors suffered very severely, many large woods being razed to the ground; their names only remaining in the localities as a proof of their former existence.

So serious had the position of affairs become that in the early years of the reign of Charles II. grave anxiety was expressed by the State Commissioners on the score of the supply of oak timber so essential for the upkeep of the "wooden walls"—in other words, the Navy, which then, as now, formed the bulwark of the country.

In 1662 the Royal Society was founded under the patronage of the King. From its inauguration, as throughout the two and a half centuries which have elapsed since that date, the Society placed the welfare of the nation in the forefront of its activities. The grave position of the oak timber supplies having been brought to the attention of the Council, they deputed one of the Society's first Fellows and Members of Council, Mr. John Evelyn, to prepare a treatise on the subject. Thus originated that great work by which Evelyn is perhaps best known, his "Sylva," or, as he terms it in an alternative title, "A Discourse of Forest Trees and the Propagation of Timber in His Majesty's Dominions." This discourse was read before the Royal Society on October 15th, 1662, and published by the Society two years later. From a forester's point of view this work is above all criticism. It stands as a lasting memorial to a highly gifted and far-seeing man, whilst at the same time giving us a clear insight into the extensive knowledge on the subject of tree-planting and all connected with it existing at the period.

But the after-results of this action on the part of the Society are even more interesting, and their significance should not be lost to us at the present time. Evelyn effectually awoke the interest in planting he set himself to secure; for in the dedication to the King in his fourth edition, published in 1678 (fourteen years after the "Sylva" first appeared), he records the fact that many millions of trees had been planted both in the Royal Forests and in privately owned ones as the direct outcome of the action of the Royal Society—a result publicly acknowledged by the King. We now come to the most interesting sequel.

A century later, in 1776, Dr. A. Hunter, F.R.S., edited a new edition of the "Sylva." In his preface he has the following remarks: "Soon after the publication of the 'Sylva' the spirit for planting increased to a high degree, and there is reason to believe that many of our ships which, in the last war, gave laws to the whole world, were constructed of oaks planted at that time."

It may be regarded, then, as tolerably certain that the oak timber required for the ships, or of which, I may say, the ships were built, which fought and won the battle of Trafalgar, was present in this country at the hour of its dire need as the direct outcome of the action of the Royal Society and the influence of the "Sylva."

Soon after its formation in 1754 the Royal Society of Arts energetically took up the question of planting, and instituted a system of premiums and medals to be awarded to those sowing and planting up the greatest areas of land. Between 1758 and 1821, 127 gold and 40 silver medals were awarded in this way, in addition to pecuniary premiums. As a result of this enlightened policy a considerable amount of planting was carried out during this period.

The grim spectre of invasion receded for a century after Trafalgar. The "wooden walls" disappeared and were replaced by steel ones. We had secured unquestioned command of the seas, and with the improved steam communication home forestry, which had been neglected to some considerable extent, began to decline rapidly. This decline proceeded at a quicker rate when the import duty was taken off colonial timber in 1846, and the removal of these duties from all foreign timber in 1866 may be said to have sounded the death-knell of British commercial forestry. Although it had been a profitable rural industry for centuries in this country, it became unprofitable. It was not that the industry would not still pay. It was simply that the old English methods of growing timber, which dated from 1540 or thereabouts, and which in that period had spread throughout this island and across into Ireland, no longer provided the clean stems free from knots required by the market. The markets had changed, and we continued on the old lines growing material for which there was no demand. Practically throughout the latter half of the last century the woods came to be looked upon chiefly from the point of view of game coverts and ornaments to large estates. We depended almost entirely on imports for our supplies of forestry materials. In 1913, the last year of which we have full returns before the war, we imported £43,000,000 sterling worth of forestry materials. In what position did the Great War find us in respect of these materials? The United Kingdom contained an odd three million acres of woodlands, for the most part kept up either for shelter or sport, and to a lesser extent for ornament. A certain proportion of this area was useless scrub. Two to three per cent. of these woods belonged to the Crown. The State owned no woods in Great Britain.

These woods had not, for the most part, in recent years been worked upon commercial principles. And the only forestry which pays is commercial forestry. We shall return to this point later on.

This brings us to the present time. The war caught us totally unprepared. The mines felt the position at once. Pit wood rose to famine rates, and many mine-owners are likely to remember the worries of August, 1914, and subsequently. Of course our hope lay in the Navy. The Navy was to see that we got all we wanted in imports. But we had not foreseen, or would not foresee, that even with the command of the seas a European war might close up the chief sources of our supplies. And yet this, in combination with an insufficiency of freight ships, is what has taken place.

Nor, apparently, did we foresee that in the absence of adequate supplies grown at home we should have no hold over the market and prices. What is the present position? We have spent large sums of money on timber for Naval and War Office purposes—money which has gone, for the most part, into the pockets of neutrals. Prices have reached a level which would have been regarded as incredible before the war. We are now engaged in cutting down, in sacrificing, such woods as we have in this country. And we have, say, some 5,000,000 to 9,000,000 acres of land in these islands which expert opinion is unanimous would grow timber, and a considerable proportion of which would carry fine crops of commercially profitable timber trees.

It is not, however, a consideration of what might have been which should occupy our energies at present. The two problems as they appear to present themselves are: (1) The present position of timber supplies and the position which will face the Allied Powers at the close of the war; (2) What should the country do to ensure that our posterity shall not have to face a position similar to the one confronting us to-day?

(1) The present position of timber supplies and the position which will face the Allied Powers at the close of the war.

The present prices of timber are inordinately high. In this country the following rates are in force for the materials in common use, as compared with pre-war prices :—

PRE-WAR PRICES COMPARED WITH PRESENT PRICES.

PRE-WAR PRICES.

Timber.

Pre-War Rates per cubic foot.

	Net Prices. s.	d.		s.	d.
Larch	–	11	to	1	–
Scots Pine	–	5	,,	–	6
Spruce	–	4	,,	–	6
Oak	1	3	,,	1	6
Ash	1	6		–	–
Elm	1	–		–	–
Birch (for bobbin wood), per ton (delivered)				26	–
Beech, rough (for bobbin wood), per ton (delivered)				24	–
Beech (clean)				1	2
Sycamore (for rollers, bobbins, etc.) per ton				28	–
Sycamore (large-sized timber)	2	6	,,	5	–

Colliery Wood.

Pit Wood per 100 lineal feet.

		s.	d.
Pit Props, Scots Pine (top diameter 3")		4	6
,, ,, (,, 4")		6	–
,, ,, (,, 5")		9	–
,, ,, (,, 6")		12	–
,, Larch (,, 3")		–	–
,, ,, (,, 4")		18	–
,, ,, (,, 5")		26	–
,, ,, (,, 6")		32	–
Pit Sleepers (3' × 5" × 2")	per 100	12	6
,, (3' 6" × 5" × 2")	,,	14	9
,, (3' 9" × 5" × 2")	,,	16	–

Railway Sleepers.

		s.	d.
Pine	each	3	6

PRESENT PRICES.

Timber.

Present Rates per cubic foot.

	Net Prices. s.	d.		s.	d.
Larch	1	–	to	1	1
Scots Pine	–	8	,,	–	8¼
Spruce	–	8	,,	–	8¼
Oak	1	3	,,	1	9
Ash	2	3	,,	3	–
Elm	1	–		–	–
Birch (bobbin wood) per ton				10	–
Beech (rough, for do.) ,,				10	–
,, (clean)				1	2
Sycamore (for rollers, bobbins, etc.) per ton				28	–
Sycamore (large-sized timber)	2	6	,,	5	–

Colliery Wood.

Pit Wood per 100 lineal feet.

		Delivered. s.	d.
Pit Props, Scots Pine (top diameter 3")		16	6
,, ,, (,, 4")		22	6
,, ,, (,, 5")		28	6
,, ,, (,, 6")		33	6
,, Larch (,, 3")		16	6
,, ,, (,, 4")		22	6
,, ,, (,, 5")		32	–
,, ,, (,, 6")		38	–
Pit Sleepers (3' × 5" × 2")	per 100	26	–
,, (3' 6" × 5" × 2")	,,	31	–
,, (3' 9" × 5" × 2")	,,	36	–

Railway Sleepers.

		s.	d.
Pine	each	5	9

Comment on the above figures is scarcely necessary. They are a direct outcome of two facts—the first, an almost total lack of interest on the part of the nation as a whole in all pertaining to the economic questions involved in commercial forestry and the maintenance in these islands of that acreage of woods managed commercially which our population and industries demand; and, secondly, to the failure on the part of the Governments of the past fifty years, to go back no further, to realise the position in this respect which would confront the nation in the event of just such a European conflagration as has taken place. The Government existing in this country 250 years ago was more clear-sighted. True, it may be said that our "wooden walls" of that day and the necessity for maintaining them were factors which both Government and the public could more easily grasp. But no Government of the present day would care to shelter itself behind such a plea. Our economic needs in timber are far greater now. We have only to look at the gigantic imports—they rose by twelve million pounds in the four years from 1909 to 1913—to realise this.

But we are not concerned with "might have beens." The point is, where are we to look for supplies, and, having found them, what steps should be taken to ensure that they shall be fully utilised at reasonable prices at the end of the war? It appears imperative that this question should be solved, and solved in time.

What is the present position of affairs in Europe? Incalculable devastation has been committed in the areas in which the war is being waged. Countless families are homeless. Building on a stupendous scale will require to be undertaken. Where is the timber required for

this new construction work to come from? And what price is to be paid for it? Is the end of the war to witness a ruinous competition between the Allied countries in the timber markets of Europe? And are colossal sums to be spent, colossal fortunes to be made, in rebuilding the devastated cities, towns, and homesteads which war has destroyed?

This is one direction in which a definite understanding should be come to between the Allies before the war terminates.

On what lines should an understanding of this nature proceed? It may be contended that the end of the war will witness the re-opening of the ports and a resumption of the timber exports without the interference of Government. This, it is to be hoped, will take place, but it will not bring down prices. We see congratulatory remarks made on the assistance which America, Canada, and Newfoundland are giving by the large consignments of timber, wood pulp, etc., they are sending us. But the supplies are the outcome of the high prices. Heavy fellings are being made in our own woods under the auspices of the Home Timber Committee in order to supplement these imports. Lord Selborne's well-timed action in appointing the Home Timber Committee was wise. There are two points in connection with these home timber fellings, however, which might, without undue hardship, be insisted upon, (*a*) All woods purchased and felled by Government at the present high rates should be at once replanted by the owner as a condition of contract; (*b*) the Home Timber Committee should keep a careful record of the amounts of material cut from the areas they purchase, its nature, locality in which grown, etc., for this will prove a valuable record in future planting operations.

But neither the present imports nor the fellings in our own woods will bring down prices. That supplies are being obtained is satisfactory at the present moment, for we are at war. The material is urgently needed, and must be obtained from somewhere, no matter what the price that has to be paid. But are we going to continue indefinitely paying these exorbitant rates? And we cannot even depend on obtaining all we require—witness the recent action of Sweden in prohibiting imports of wood pulp, and our own Government's enforced action in this respect. Its effect on the press at once demonstrated our entire dependence upon imports. It is doubtful if the termination of the war will witness any great diminution of the timber demands. Rather an increase is to be expected. To add to the Allies' gigantic war bill by a subsequent outlay for timber for rebuilding purposes at double or treble its pre-war rates will be a suicidal and unstatesman-like result of a *laisser aller* policy. One has heard it said in reference to this and other kindred economic questions, "Oh! war time is not the time to consider such matters." I venture to think, in view of the demand which must ensue with the advent of peace, that this question is pre-eminently one which must be settled now; for the termination of the war will be too late. We had not the foresight to grasp what would happen at the outbreak of this colossal war. Let it not be said of us that its termination found us in the same state of unpreparedness.

My proposition is that the Allies should place themselves in a position to control the European timber market at the end of the war—to exercise, in fact, a State control over prices for a time, as the only effective means to cope with the enormous demand which will exist, and to prevent the formation of timber "rings," either by the Central Powers or others. It is no plea that such a thing has never been done before. The end of the war will find us, the war itself is finding us, doing a good deal we never thought to have to do.

First, then, we want to place our finger on accessible supplies in large quantities and owned by the Allies; and, secondly, to come to an agreement by which these supplies can be made available at the earliest possible moment with the object of bringing down the present preposterous rates.

If we examine the forestry resources of the Allies, the one great fact which immediately becomes apparent is the gigantic area of the forests in Russia, the Land of Forests, as it has been termed. For some years past I have made some study of the forests of European Russia, and also those of Finland and Siberia, and have some papers in course of publication on this subject. It is a most unfortunate thing for this country that we have known so little of Russia in the past—of its enormous possibilities and potentialities, and its great value in many ways to this country. Germany discovered it. Russia is honeycombed with Germans and German enterprises, mostly conducted, not for the welfare of Russia or in the interests of Russia and her people, but for the furtherance of German empire objects, and of those alone. Even in the matter of forestry imports Germany was undermining our pre-

viously unquestioned supremacy in the Russian timber markets. Germany has vast forest resources in her own country, a considerable portion of which is afforested; and not only afforested, but with the woods managed on the highest commercial basis possible. And yet in recent years her imports from Russia have increased rapidly, the increase being greater in proportion than the increase to Great Britain. And she has been importing from elsewhere also. Why? Was it because she really required the materials, or is the reason to be found in the fact that she has been deliberately storing up her woods, undercutting in them, with a set purpose in view? Did her wonderful organisation for this world war, and her deliberate intention to make it as frightful as possible, foresee the enormous damage that would be done to towns and the enormous demand which would exist for timber at the close of the war? During the war we know that she has been cutting down the woods in the territory she has occupied, and either utilising the materials for trench construction or other purposes, or storing them up for the great demand she expects at the peace. We know how Belgium is suffering in this respect.

From Russia we imported 35 per cent. of our European timber supplies in 1913. In Russia the Allies have for the purpose here considered a source of supply which should fulfil the objects required. Russia in Europe has an area of 447,500,000 acres of forests; Finland, 62,800,000 acres; and Siberia and Turkestan, the gigantic total of 853,000,000. Now much of this area in Russia, Finland, and Western Siberia produces the very materials which will be required in such enormous quantities at the close of the war, and which we import in such large amounts. And vast tracts of these forests are unworked or but slightly worked. A few years back the Government estimated that the fellings in the forests of Russia in Europe were something under 50 per cent. of the possibility. For instance, in the forests in the north, which are difficult to work owing to defective communications, only ·7 cubic feet per acre were felled out of an estimated 7 cubic feet. Fellings have improved somewhat since, but are still below the possibility. In Finland, again, published figures for the State forests show that, whereas in 1908 the mean annual increment put on per acre was estimated at 21 cubic feet for the whole country, the total amount sold was only 3·4 cubic feet per acre. Further, it was calculated that there were over 121 million trees of approximately 10 in. diameter and over at chest height in the State forests, and probably a like total in the privately owned forests. The gigantic tract of the Siberian forests is only partially explored, but estimates framed for 1911 show that 1,800,750,000 cubic feet of timber were available for sale in the State forests which had been explored, of which only 10 per cent. were disposed of. Russia has, then, large areas of accessible forests, or forests which, by a not very heavy expenditure, can be made accessible. She also has a very large population. Under the methods in force for exploiting this forest wealth, there exist throughout the country over 2,000 saw-mills. The war will leave her, however, with very little capital. Firstly, money, and next to that organisation, are necessary to open out these resources. My suggestion is that Russia should be asked by the Allies—by the British Government, if necessary, since we are very deeply concerned in this matter, as, unlike our other Allies, we have no forest resources of our own at our backs—to institute fellings on a large scale in those of her forests which are adjacent to the most suitable ports. Every saw-mill in these regions should be set to work converting timber at high pressure and stacking it in suitable depôts for transport to the areas required at the earliest possible moment. A definite scheme for the freight vessels necessary should be drawn up, and the tonnage required be earmarked for the purpose for which it is to be employed. As soon as the ports, or any port, of supply become open, a part of this tonnage should be made available to start bringing the materials ready to the spots arranged upon. This question of freight vessels has been very much before the public latterly. In itself it has greatly enhanced timber prices. The maintenance of the present prices is no more to Russia's advantage than ours or any of the other Allies, since we all have to foot the bill. To undertake the above sketched scheme money will be required to finance the saw-mills, open up inaccessible areas, pay the sawyers, and so forth, and my suggestion is that the British Government advance the sum which will be required for the purpose; whatever the sum necessary, it would be a mere bubble in the enormous present expenditure, and the savings which would ultimately result would several times over recover the sum spent. It would be money well laid out.

All that is required is a practical working scheme. So far as my study of the question has led me, it appears that the one practical possibility is to be found in Russia, and Russia

alone. It appears to be inadvisable to depend on the possibility of obtaining the materials to any great extent from the forests of the Central Powers. We have to beat them first. No one doubts that we shall, but no one knows how long the war will be prolonged. We should face the position as it now is, and make arrangements which will depend for their fulfilment on the Allies alone and on their resources. I have only here attempted to outline a suggested scheme. Time will not permit me to do more.

I come now to a point which is supplementary to the one we have just considered. If afforestation is taken up in this country (I am coming to that) on the scale now so urgently needed, we shall have to wait about thirty-five to forty-five years to obtain pit props from the woods, and longer for large timber.

I would suggest that to tide over this long period we should lease for a period of years a large area, or several areas, of the Russian forests and work them ourselves, in order to ensure that this country obtains a proportion of what she requires in timber, etc., independent of extraneous imports and at a reasonable price. our posterity should never have to face a position similar to the one which has confronted the nation since the outbreak of war.

In my opening remarks I drew attention to the position in afforestation matters existing in the early days of the reign of Charles II. We are in infinitely better case to-day, as we no longer require to wait the long periods necessary for the growth of large oak timber. Thirty-five to forty years will grow pit-wood crops and paper-pulp wood; and double this period most of the other conifer wood we so largely use.

It is not proposed to burden this paper with a wealth of statistics. But it will be of interest to glance at the areas of land in Great Britain and Ireland, and the proportion of woodland and mountain and heath land to total area. Roughly speaking, over nine-tenths of our wood imports are of coniferous timber. Now coniferous trees are just the class of trees which we can grow, and grow successfully, on the better portions of our waste lands. Britain, once covered with forests, is now one of the most poorly wooded countries in the world. The land areas are, roughly, as follows:—

	Land Area.	Woodlands.	Mountain and Heath Land.	Percentage.	
				Woodland.	Waste Lands.
England	32,381,000	1,666,000	2,306,000	5·1	7·1
Scotland	19,069,000	879,000	9,375,000	4·5	48·1
Ireland.	19,323,000	303,000	3,780,000	1·5	18·5
Wales	4,748,000	182,000	1,251,000	3·8	26·2
Total	75,521,000	3,030,000	16,712,000	3·9	21·6

I would ask, can we hope to get what we want at a reasonable figure in the future in an open market during the next forty years? Is it likely?

We can no longer afford to pay fancy prices for our timber requirements, and certainly not if there is a way out. Such a way I venture to think lies in these enormous Russian forests, these unexploited Russian forests not one-tenth of which Russia herself is likely to possess the capital to exploit during this period. Their resources are enormous. Why, then, should not this country arrange for a lease of portions of them to help make a certainty of our supplies during the period our woods are attaining a cutting size?

(2) *Our duty to posterity.* I now turn to the question of what should be done to ensure that

The percentage of woodlands in Great Britain and Ireland is 4 only. The area of mountain and heath land runs to over 16½ million acres, and much of this at present brings in a very small annual return—roughly, save in exceptional circumstances, from 2*s.* 6*d.* per acre to a few pence per acre only. There is a good deal of the latter in Scotland.

I will commence by briefly indicating what we have been doing towards attempting to ameliorate the returns from this poor land.

During the past quarter of a century several Committees have been appointed to deal with the Forestry question. The result, so far as the actual planting of woods for commercial purposes is concerned, has been *nil.* In 1887 a Parliamentary Committee considered this question and made recommendations. Had these been given

effect to, and had planting on a considerable scale been undertaken as a result, we might now have had a series of woods from which we could have drawn a supply of pit timber for the mines. Well-grown woods of this age are being cut down for this purpose at the present moment. But we did nothing. Again in 1902-3 a Departmental Committee of the Board of Agriculture reported on the subject. Unfortunately, it did not advocate any large planting scheme, but made valuable recommendations on the subject of a more extended system of forestry education. Effect was given to these recommendations in different parts of the country, and the question has since received hearty support from the Development Commissioners. But no planting was done. In 1908 a Committee appointed by the Department of Agriculture in Ireland recommended a scheme of planting up 700,000 acres in that country. Purchases of land for this purpose by the State were commenced in Ireland, and the work has since received considerable support from the Development Commissioners, and what may be termed a State Forestry Department has come into existence in Ireland.

In 1906 the Royal Commission on Coast Erosion and Afforestation was appointed. The Committee examined numerous witnesses, including all the expert advice procurable, and issued its Report in 1909. This Report recommended the planting of 9,000,000 acres by the State, of which 6,000,000 were to be planted in Scotland and the balance in England, Wales, and Ireland. With the exception of Ireland nothing was done. No planting was undertaken in Great Britain.

In 1911 a Departmental Committee on Forestry in Scotland was appointed, and issued its Report in 1912. In addition to recommendations on the subject of forestry education and the acquisition of a demonstration forest area, the question of afforestation in Scotland was considered. Flying surveys of the country were advocated in order to ascertain the available planting areas, the establishment of a limited number of State trial forests, and the appointment of an Advisory Forest Officer. The last recommendation of the three has been given effect to. In 1912 a very practical Report was drawn up by Lord Lovat and Colonel Stirling of Keir, late President of the Royal Scottish Arboricultural Society, and was published under the auspices of that society. I allude to the Glen Mor Survey. This work practically drew up what the forester would term a plan of operations for the afforestation of 60,000 acres in Glen Mor, through which runs the Caledonian Canal. To those interested in this matter, and to the nation at large, I recommend a perusal of this interesting and valuable scheme.

The Development Commission was appointed in May, 1910. During the six years of its existence it has enthusiastically taken up the forestry question. Briefly, at the outbreak of the war, as a result of its work, the position was as follows:—In England the counties had been formed into natural groups and a forestry adviser, who was attached to a university or college, had been appointed to each group, the salaries of these officers being paid from a grant from the Commissioners' funds. In Scotland an advisory officer to the Board of Agriculture had been appointed, and advisory officers were being appointed in the west and east of the country. But the Commissioners had gone further than this. They recognised that if the large areas of waste land existing in this country eminently suitable for afforestation were to be planted up, it was no longer possible to expect private proprietors to be able to find the necessary money. In fact, they realised that the work had now become a national one. The problem was admittedly difficult, but after careful inquiry into the various conflicting interests they offered a solution on the following lines.

The owners of the greater bulk of the afforestable land, in blocks of size suitable to achieve the aims of commercial forestry, consisted of large city corporations, water trusts of the great cities and towns possessing large catchment areas, and large landed proprietors.

To such bodies and proprietors the Commissioners were prepared to provide money for afforesting suitable areas, on the understanding that the land should be reserved for afforestation on commercial principles for at least one complete rotation. No rent would be paid for the land, but the landowner would receive his fair share of the proceeds for the timber grown on the area. The Commissioners would advance the money required for the planting work. The landowner's share of the ultimate proceeds would be based on the proportion which the rental value of the land bears to the estimated capital expenditure required to produce the crop.

The proportion of the receipts to go to the owner of the land were to be a matter of negotiation and arrangement between the proprietor and the Development Commissioners at the start in each case. It would be based on the present rental value of the land, its character, and other circumstances affecting the finance of the scheme.

Owing to the necessarily great variation in these data, it was not possible to draw up any general terms of assistance. The only stipulations, or probably the chief ones, laid down for advances of this nature were that the land to be planted should be in a sufficiently large block (500 to 1,000 acres) to be commercially exploitable when the woods reached maturity, and that these latter, from the time of formation, should be skilfully managed in accordance with a previously drawn up working plan and regular inspection by the district forestry advisers. It was also laid down that the afforested areas should be available as demonstration areas for the use of students and others interested in forestry—a condition which has been readily accepted.

The sums advanced were to be on a maximum basis of £5 per acre, including the fencing of the plantations, the loan to carry an interest of 3 per cent.

Up to the outbreak of the war loans of this nature had been made or promised for the afforestation of their catchment areas to the following corporations and water trusts in England and Scotland:—

England.

Liverpool.—A large area on Lake Vyrnwy, in North Wales, is being afforested on the above conditions; Liverpool having led the way in this new departure, readily acquiescing to the condition that the area should be available as a demonstration area.

Manchester.—Has been afforesting her catchment areas at Thirlmere, etc., during the past twenty years out of funds provided by the Corporation.

Birmingham.—Has a magnificent unplanted area in Central Wales, and has been for some time considering the question of afforesting it.

Leeds.—Is also contemplating the advisability and advantage to be gained by afforesting the land of this nature it possesses.

Scotland.

Edinburgh.—The Edinburgh and District Water Trust have commenced the afforestation of 600 acres of their Talla catchment area, and are also afforesting areas round their smaller reservoirs. The members of the Edinburgh Water Trust, by their enlightened policy, thus led the way in this matter in Scotland.

Lanarkshire.—A scheme for afforesting part of an area of 5,000 acres on the Camps catchment area owned by the Lanarkshire County Council has recently been adopted by that enlightened body, and the planting work has been commenced.

Other places are also considering the matter, but for various local reasons have not yet started their schemes.

It will be seen, therefore, that a commencement of this important work had been made before the war broke out. More important still, perhaps, is the fact that a number of the business men of the country had shown by their accepting the offer of the Development Commissioners that they realised the great possibilities of afforestation in this country. And this realisation had come to them before the war. The aspect of the question has now entirely changed. As has been shown, the price of timber in the future will certainly be greater than in the past, and afforestation will prove a paying investment.

Ireland.

The land conditions in Ireland are different, and a State Forest Department is now in existence. Land has been purchased, and three large centres are now owned by the State, and are being planted out of funds from the Development Commissioners. These areas are in Central Wicklow, County Cork (Ballyhoura), and Queen's County (Slieve Bloom).

This was, broadly speaking, the position of affairs at the outbreak of war. Now it is not open to doubt that the war has intensified the urgency of the afforestation question in this country. However near to their former level we may be able to bring prices, the tendency of the future will be an inevitable increase. For years the possibility of a timber famine in Europe has been discussed by experts as the probable outcome of the utilisation of the accessible available supplies in different parts of the world. That prices would have risen in a comparatively few years even without the war was a certainty. The war leaves the question in no doubt. Consequently forestry—commercial forestry—will be an even more paying proposition in the future than would have been the case.

And I believe all experts are convinced that, far from postponing the matter for any further consideration, steps should be taken now to prepare schemes of sufficient magnitude to ensure both success and adequate supplies for posterity. As a nation we are ever more wideawake in times of stress and danger; and since peace failed to bring this question home to us, even with the numerous Committees and Royal

Commissions which have sat upon it, may we not hope that the stress of war and the price we are paying for our fathers' dilatoriness may rouse us to its great urgency?

It will be said that money will be harder to get; interest will be higher: 5 per cent. will be now asked instead of 3 per cent. Granted, but with a return of prosperity this percentage should drop, and may even reach 3 per cent. again before the completion of the work. And it must be remembered that the additional cost should be well repaid by the excess price of the wood, which will be, so far as can be foreseen, some 25 per cent. to 30 per cent. higher than in pre-war days, as the supplies we have depended upon for the last thirty to forty years become cut out. Further, the investment will be a sound one. For when the woods become ready for the axe our children and grandchildren can utilise the considerable sums which such an investment will give them to defray some of the enormous national debt with which the country will be saddled. If from no other point of view, the planting of our waste lands, at present bringing in from 1*d*. to 6*d*. per acre, will be a sound investment. Had our grandfathers sixty to seventy years ago planted up a proportion of the waste lands of these islands, we should have been saved a large sum of money and a great deal of anxiety during the past year and a half. Had our fathers planted thirty to forty years ago, the pit wood required for the mines would have been available in this country, and the great trouble to which mine-owners were put and the ruinous prices they are paying for their timber, and we are all paying for our coal, would not have existed. Paper pulp from areas of spruce woods, which many parts of our lands can grow to perfection, would also be available, and the press would not be faced with the position which the action of a neutral and a scarcity of tonnage has now placed them in. And we should not be so alarmed at the thought that our morning paper and "extra specials" are going to become a luxury which we may even have to forego.

We have also a further problem confronting us in the provision of work for partially incapacitated soldiers and sailors, and of employment for the numbers of young men who, leaving their former sedentary occupations, have gone out to fight for the country. On their return these young men are likely to look with distaste at their former work. They will ask for a more active life. If that life cannot be provided for them in this country they will emigrate. And yet, if a campaign to plant up our waste lands, the present position of which is economically a disgrace to the nation, and one very far removed from the thrift and conservation and rehabilitation of the national resources which is now being so strongly advocated—if, I submit, a campaign of sufficient magnitude is undertaken to plant up these derelict acres which could grow so much of what we want, we should be able to provide employment for these young men; as also for our partially incapacitated soldiers and sailors.

One of the reasons why the recommendations of the Coast Erosion Commission were not acted upon was said to be the impossibility of employing the townsman in planting work owing to his inability to stand the strain and exposure of working on the soil, and his ignorance of the use of the spade and pick. That this was a fallacy the war has proved. Modern warfare entails the constant use of both these implements. In fact, they are probably used as much as the rifle, if not more so. The men of the towns have stood their training in the use of these tools, and numbers of youngsters, having a thorough acquaintance with them, and also hardened to exposure, should be available for afforestation work. With these facts staring us in the face, will it not strike us that the crusade preached by Evelyn two and a half centuries ago, and the Spirit for Planting—as it was quaintly termed—which it aroused, should once again be raised throughout the country, and that the few who have preached it in and out of season during the last quarter of a century should now have the nation at their back? After all, it is a question for the country. There are 3,000,000 acres of so-called afforested land—of woodlands. And we have, say, 9,000,000 acres of afforestable land; put it at 7,000,000, or even 5,000,000. It will do to go on with. It has been stated by many who know what they are talking about, that this land, or much of it, will bring in more under trees than under any other form of cultivation; or, to put it in another way, that this land will prove a greater national asset under woods than managed in any other way. Why not, then, set to work and get it planted up? If for no other reason than the one of national economy, the matter must be regarded as one of urgency. We can no longer afford to leave any source of national wealth unexploited. We must all agree that it has become a duty—a national duty—to see that every acre of land in this country is made to bring in the best return possible in the interests

of the community as a whole. Well, there exists a considerable acreage of land which experts are agreed is not bringing in anything like an adequate return. This land can be made to grow produce which is in great demand in the country, and which, in the absence of home-grown supplies, necessitates large imports that have to be paid for, and are going to be more expensive in the future. The aspect of the forestry problem has entirely changed from its pre-war position. The prices of timber are not likely to fall to their former level. So long as prices were low there was a good deal to be said for those who were against afforestation in this country. They put forward arguments which had certain elements of soundness in them, *e.g.*, the contention that forestry would not return even the 2½ to 3 per cent. claimed for it. The Great War has swept away such doubts and arguments. Prices have gone up, and the nation is now assured of successful financial results from afforestation work. On all counts the planting of this land will be of immense advantage to us. It will save imports, employ labour, and help home industries. In the last connection it will do more than help. It will result in establishing new ones. For the maintenance of a considerable area of forest in a country leads to the establishment of subsidiary industries such as paper-pulp mills, saw-mills, bobbin mills, furniture manufactories, and so on. And these afford employment to a considerable head of population.

To come now to a practical suggestion. Of the 3,000,000 acres of existing woodlands, it is extremely probable that the woods of merely commercial value will have been cut by the end of the war. The considerable areas which have a value other than the purely commercial—*i.e.*, which serve for shelter to stock and crops; are intimately connected with the sporting value of estates; or are maintained for amenity purposes—will, and should be, left standing. They are, in the main, of small size, and would not come within the minimum of 500-acre blocks which commercial forestry requires if it is to prove successful. They are of no considerable importance for our present case. The young commercial woods which have not yet reached felling size, must, however, be also included here. The areas which will have been felled, together with the considerable tracts of useless scrub, may be taken at 1,500,000 acres. If we add to this area 5,000,000 acres of the poor-class waste lands which could be profitably planted, we obtain an area of 6,500,000 acres which, in the interests of national economy, should be planted up at once. Therefore the planting work resolves itself into:

(*a*) Replanting the areas felled over during the war and the areas at present occupied by worthless scrub (of which there are extensive tracts in Scotland), amounting to 1,500,000 acres.

(*b*) Planting up 5,000,000 acres of at present treeless land, selecting in each county the better areas, which will yield a good return from the capital laid out.

In view of our growing requirements in timber, it is unlikely that this area of 6,500,000 acres will, when it comes into bearing, supply us with more than two-thirds to three-fourths of our needs of the future. But if the woods are scientifically managed, such an area should place us in a position of safety in the case of a sudden national emergency.

On the subject of cost, if we take an all-round sum of £3 per acre for the felled-over area, etc., class, and £4 per acre for the waste lands, our planting cost would come to 4½ million and 20 million pounds respectively, or a total of 24½ million pounds sterling—about a week's war expenditure. If 200,000 acres were planted annually, the area would be planted in 32 years. A planting plan should be drawn up, county by county, under which the felled-over areas, scrub areas, and the most accessible of the waste lands would be selected, and the order of the planting be laid down so as to ensure a proper arrangement of the woods for felling purposes, etc.

On the subject of the labour, it should be possible to start the work on the grand scale at the end of the war, when a considerable amount of first-class labour should become available. Partially-incapacitated soldiers and sailors will also be available—in fact, are available already. The work could be commenced immediately, as a matter of fact, by employing expert planters from amongst our prisoners. Now that prisoners are being employed by Government in felling operations, there appears to be no reason why they should not be also used for planting. We could plant up thousands of acres by employing them.

All that appears to be wanted is a plan of campaign and a favourable hearing from Government. It is not demanded here that additional work should be piled upon already overworked and harassed officials. It cannot be the desire of anyone to add any extra burden to the heavy ones already being shouldered by the Government. Rather the reverse. But at the present time it becomes a duty of each one of us to do

all in our power in the interests of national economy and thrift. The termination of the war is an indefinite period. Meanwhile there are large areas of land in this country which can be better utilised in the national interest, given the inauguration of a suitable scheme. Trees take a long time to grow; even the shortest rotation for a tree crop is approximately half of the proverbial "three score and ten years." Therefore each year which elapses without a commencement being made in remedying the deplorable state of affairs is a waste of national resources which can easily be expressed in pounds, shillings, and pence. There are men in this country perfectly acquainted, by knowledge, training and experience, with such work who would be quite capable of organising a scheme of this nature, and of seeing that the nation got full return for the capital sum laid out.

Is it too much to expect that the country will realise the economic importance of getting these millions of derelict acres under a profitable crop, and insist on the job being put through?

And may we hope that the great Society which soon after its inauguration, as I implicitly believe, and as Evelyn put it, awoke in the country the Spirit for Planting, and thereby saved us from invasion in the days of Napoleon, and that this Society, who took up the cause a century later, will come to the nation's aid once again. With their powerful support we may hope to secure that area of home woods which present-day necessities demand, which a full utilisation of our national resources and the campaign for thrift in all departments of life equally demand, and which our posterity is likely to need so sorely.

THE CHAIRMAN (Mr. John Slater) said he was not very familiar with the subject of forestry, as it was only when the wood became converted into building materials that he had to deal with it. He had been convinced, however, by the author, of the great importance of the forestry question to the country, and he was quite sure that the Government would be exercising a wise prescience if they went thoroughly into the question of afforestation in this country, because he believed the author was quite right in the statement that it would be a long time before the price of timber came down. Quite apart from the immense amount of building that would have to be done after the war, there was the terrible destruction of the forests of Belgium, France, Poland, and other places by artillery, and against the lessened supply there would be a greater demand. It had been the practice of the Government for a long time to send Indian cadets for forestry training to Germany, on account of there being no facilities for that training in this country; but it was perfectly certain that it would be a long time before that practice was revived. Therefore, apart from the provision of timber, some means of instruction in forestry had to be made available. He had been through the forests of Thuringia, the Black Forest, and the forests of Sweden, and had been struck with their appearance as compared with the bleak hillsides of Derbyshire, Scotland, and other places in this country. He would conclude by proposing a hearty vote of thanks to the author for his interesting paper, and for the charming series of slides he had shown on the screen.

The motion was carried unanimously, and MR. STEBBING having briefly replied, the meeting closed.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

MARCH 22.—REV. P. H. DITCHFIELD, M.A., F.S.A., "The England of Shakespeare." HUBERT HALL, F.S.A. (Public Record Office), will preside.

MARCH 29.—R. W. SETON-WATSON, D.Litt., "Pan-German Aspirations in the Near East." SIR EDWIN PEARS will preside.

APRIL 5.—ARTHUR S. JENNINGS, "Painting by Dipping, Spraying, and other Mechanical Means."

MAY 3.—PROFESSOR W. B. BOTTOMLEY, M.A., F.C.S., F.L.S., "Bacterised Peat."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

APRIL 6.—PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India." THE RIGHT HON. LORD ISLINGTON, G.C.M.G., will preside.

APRIL 27.—JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

MAY 18.—SARDAR DALJIT SINGH, C.S.I., "The Sikhs."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

MARCH 28.—PERCY HURD, "Next Steps in Empire Partnership." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

APRIL 11.—SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland." The Right Hon. SIR WILLIAM MACGREGOR, P.C., G.C.M.G., C.B., will preside.

Dates to be hereafter announced:—

SIR FRANCIS TAYLOR PIGGOTT, M.A., LL.M., Chief Justice of Hong-Kong, 1905–1912, "Contraband and Blockade."

JOHN COLLETT MOULDEN, A.R.S.M., M.Inst.M.M., "Zinc, its Production and Industrial Applications." (Peter Le Neve Foster Prize Essay.)

G. P. BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m.:—

EDWARD A. REEVES, F.R.A.S., F.R.G.S., Map Curator and Instructor in Surveying to the Royal Geographical Society, "Surveying, Past and Present." Three Lectures.

Syllabus.

LECTURE I.—MARCH 27.—*Historical Sketch.* Introductory remarks—First attempts at surveying—Early surveying instruments and methods—First attempts at measuring size of earth—How early charts and maps were made—Beginnings of astronomical observations for fixing positions—Improvements in instruments and methods introduced in fifteenth century—First triangulation—Survey basis of early British maps—Further improvements in instruments and methods.

LECTURE II.—APRIL 3.—*Present position of Surveying and Mapping of the World.* General account, illustrated by maps and diagrams showing (1) parts of the world topographically mapped from reliable surveys, (2) those less accurately mapped from surveys chiefly non-topographical, (3) parts only roughly mapped from route traverses, and (4) those still entirely unsurveyed—Facsimiles of MS. maps of well-known explorers—Specimens of different kinds of surveys from which the earth has been mapped, with general account of them—Part taken by the Royal Geographical Society in promoting exploration and surveying—Work of the future.

LECTURE III.—APRIL 10.—*Modern Instruments and Methods of Geographical Surveying.* Advance made in recent years—Difficulties of obtaining accurate measurements—Circumstances that determine character of survey—Theodolites—Base line apparatus—Triangulation, with recent examples—Traverses with theodolite and tacheometer or subtense instruments—Plane-table, its use in topographical mapping, and recent improvements—Determination of heights—Photographic surveying—Astronomical observations for fixing positions.

The lectures will be illustrated with lantern-slides.

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m.:—

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 20...Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. Prebendary H. E. Fox, "Inscriptions and Drawings from Roman Catacombs."

East India Association, Caxton Hall, Westminster, S.W., 4.15 p.m. Sir Guilford Molesworth, "The Common Origin of the Religions of India."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Dr. W. Leaf, "The Military Geography of the Troad."

London Chamber of Commerce, Oxford-court, Cannon-street, E.C., 2.30 p.m. Mr. E. Crammond, "British and German War Finance."

TUESDAY, MARCH 21...Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m. Sir George Paish, "War Finance."

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Discussion on "Some Aspects of the Design and Use of Glassware in relation to Natural and Artificial Illumination."

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. 1. Valedictory address by the President, Sir Boverton Redwood. 2. Dr. J. A. L. Henderson, "The Natural Gas Industry: its Progress and Importance."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Keith, "Sea Power as a Factor in the Evolution of Modern Races." (Lecture II.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Sir George C. Buchanan, "The Rangoon River-Training Works."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Mr. J. T. Cunningham, Exhibition of skins illustrating results of Mendelian Cross in Fowls. 2. Mr. R. I. Pocock, Lantern-exhibition to show structure of the Alisphenoid Canal in some Civets and Hyænas. 3. Dr. T. Goodey, "Observations on the Cytology of Flagellates and Amœbæ obtained from old stored Soil." 4. Major R. Meinertzhagen, "Notes on the Sitatunga or Marsh-Antelope of the Sesse Islands."

Electrical Engineers, Institution of (Local Section), 17, Albert-square, Manchester, 7.30 p.m. Mr. N. W. Storer, "The Use of Continuous Current for Terminal and Trunk Line Electrification."

WEDNESDAY, MARCH 22...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Rev. P. H. Ditchfield, "The England of Shakespeare."

Geological Society, Burlington House, W., 8 p.m.

Literature, Royal Society of, 20, Hanover-square, W., 5 p.m. The Dean of Durham, "Bishop Warburton's Critical Notes on Neat's 'Puritans.'"

Garden Cities and Town Planning Association, Mansion House, E.C., 3 p.m (Annual Meeting.) Report on the proposed Establishment of Small Holdings Colonies for Discharged Sailors and Soldiers.

Japan Society, 20, Hanover-square, W., 8.30 p.m. 1. Mr. W. Crewdson, "Japanese Leather." 2. Mr. A. J. Koop, "The Use of Leather in Japanese Military Equipment."

THURSDAY, MARCH 23...Royal Institution, Albemarle-street, W., 3 p.m. Professor H. E. Armstrong, "Organic Chemistry in War—Organic Products used as Propulsive and Explosive Agents." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8 p.m. Mr. A. Stewart, "The Development and Application of the Telephone."

FRIDAY, MARCH 24...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor W. M. Bayliss, "The Mechanism of Chemical Change in Living Organisms."

Engineers and Shipbuilders, North-East Coast Institution of, Newcastle-on-Tyne, 7.30 p.m.

University of London, at the London School of Economics and Political Science, Clare-market, W.C., 5 p.m. Mr. C. Turnor, "The Land and the Empire." (Lecture III.)

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

SATURDAY, MARCH 25...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Radiations from Atoms and Electrons." (Lecture III.)

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FRIDAY, MARCH 24, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

NEXT WEEK.

MONDAY, MARCH 27th, 4.30 p.m. (Fothergill Lecture.) E. A. REEVES, F.R.A.S., F.R.G.S., Map Curator and Instructor in Surveying to the Royal Geographical Society, "Surveying: Past and Present." (Lecture I.)

TUESDAY, MARCH 28th, 4.30 p.m. (Colonial Section.) PERCY HURD, joint author of "The New Empire Partnership: Defence, Commerce, Policy," "Next Steps in Empire Partnership." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

WEDNESDAY, MARCH 29th, 4.30 p.m. (Ordinary Meeting.) R. W. SETON-WATSON, D.Litt., "Pan-German Aspirations in the Near East." SIR EDWIN PEARS will preside.

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 22nd, 1916; HUBERT HALL, F.S.A. (Public Record Office), in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Deb, His Highness Raja S. Tribhuban (of Bamra), Bamra, Deogarh P.O., Sambalpur, India.

Major, John Grayling, Clevedon Lodge, West Park, Eltham, Kent.

The following candidates were balloted for and duly elected Fellows of the Society:—

Middleton, Austin R., Baltimore, Maryland, U.S.A.

Patel, J. M. Framjee, J.P., Cumballa Hill, Bombay, India.

Starr, William J., LL.B., Eau Claire, Wisconsin, U.S.A.

THE CHAIRMAN, in introducing the author, said it was scarcely necessary for him to say anything about Mr. Ditchfield, who was known to many as an antiquarian of very sound learning, and as an interesting writer, whose style was never dull.

The paper read was—

THE ENGLAND OF SHAKESPEARE.

By P. H. DITCHFIELD, M.A., F.S.A.

It is fitting that in this year of grace, 1916, 300 years after the soul of England's greatest national poet passed away from earth, his countrymen should again crown him with their wreaths of laurel and unite in honouring his memory. It is fitting that on the advent of St. George's Day, the day on which the poet died, the thoughts of the members of this learned Society should turn towards our hero poet. But for the din of war and the world-wide clash of arms, a greater and a grander commemoration would have been possible. Foreign nations would have sent their tributes of praise and respectful homage to the poet's greatness. In no other country besides our own is Shakespeare more honoured than in Germany. I have met socially, and at a lecture, the distinguished German scholar, Professor Brandl, who two years ago lectured before the British Academy at Burlington House. Shakespeare was his hero, his unsurpassed poet, genius, dramatist and *litterateur*. In their affection and appreciation of the poet, Germany and England were united by close ties which could never be severed. German scholars vied with our English professors in trying to solve the mysteries of his surpassing genius. The two nations were made akin by the influence exercised by the poet, an influence that would increase as the years passed on, and produce peace and harmony between the German nation and our own.

That prophecy has been fearfully falsified. We should like to hear an expression of the Professor's views at the present time. Probably he has joined the pleasant company of other German writers, who maintain that our poet has left his native shores and sought an asylum and an enduring home in the happy Fatherland. One of our greatest authorities on Shakespeare, Sir Sidney Lee, has well said: "We welcome the

homage which Germany pays Shakespeare. We treat that homage as a tribute, in whatever spirit rendered, to poetic genius and power which are essentially English. The German homage to Shakespeare is an involuntary confession. There are lessons which Shakespeare can teach that the German has yet to learn, and we can wish nothing better for them and for ourselves than that they should supply the defect at an early date."

In spite of the strictures of Victor Hugo,* and the criticisms of Georges Pellissier†—who contends that the poet, the *dieu du théâtre* as he appears to most of his countrymen, was a bad dramatist—Shakespeare, ever since the days of Louis XIV., has found a welcome in France, and Voltaire sang his praises and sounded the trumpet of his fame in every European country.

This year we cannot celebrate the tercentenary of the poet as we should like, but not a few men and women of England have, by a study of the great national poet's writings, been braced to endure hardness, and by reflecting upon the achievements of the past have been encouraged to face the future with a high courage and a determined step.

One feature of Shakespeare's writings is his intense and ardent patriotism, his love of the England he knew, which we shall try to describe this afternoon. He loved

. . . that white-fac'd shore
Whose foot spurns back the ocean's roaring tides
And coops from other lands her islanders,
Even till that England, hedg'd in with the main,
That water-walled bulwark, still secure
And confident from foreign purposes.‡

Again, in the same play ("King John"), he utters the proud defiance of England's foes—

This England never did, nor never shall,
Lie at the proud foot of a conqueror.

* * * * *

Come the three corners of the world in arms,
And we shall shock them: nought shall make us rue,
If England to itself do rest but true.§

I should like to remind you of other passages in the plays breathing forth a resolute spirit and an undaunted heart, which, after the lapse of 300 years, are still the characteristics of Englishmen, and which will carry us through this greatest crisis in our great country's story.

My task this afternoon, however, is to bring before you the England that Shakespeare knew, the kind of buildings and surroundings on which his eyes were accustomed to rest, whenever he wandered away from the great city of London in the company of players, or abode in tranquillity at Stratford-on-Avon. He was a great traveller along our country roads. Oxford he knew well, where he often stayed at the Crown and, it is said, admired Mistress Davenant, the innkeeper's wife. In 1593 he went to Bristol with Lord Hunsdon's company of actors, whence he wandered by the Severn River to Shrewsbury, and then by Stratford back to London. In 1603 he was at Coventry, and later on Leicestershire knew him, and Coventry and Marlborough, and the towns and villages through which he passed. He was a much-travelled person, journeying in his early days on foot, and in the time of his affluence on horseback. The days of coaching were not yet. I am going to tell you of the manor houses and the humble dwellings of the poor that studded the countryside when Shakespeare wrote his immortal plays, and of the village life which he knew so well, and which finds reflexion in his verse.

Every person is in some way influenced by his environment, even a poet who creates. He is dependent upon what he sees and hears, upon the age in which he lives, on the tone and temper of that age. To know the surroundings of a man is to come nearer to the man himself, to see things with his eyes, and almost to touch that untold life which throbs within and behind his works, like the inner brightness that seems ever glowing from beneath the surface of the purest marble.

I may only touch upon one or two features of this Shakespearean environment, the material things upon which his serene brown eyes rested, and perhaps hear some of the strains of rustic revelry and the quaintness of the folk-drama that find expression in the antics of Bottom.

Our first thoughts will go back to that first twenty years of his life spent in the heart of England, that middle shire so picturesque and richly storied, Warwickshire, and to that quaint old town of Stratford which was ever dear to the poet's heart. His writings show that his mind was imbued and his imagination stirred by the legends and traditions of his native shire, by wandering amidst the woodland haunts of the Forest of Arden, by the beauty, variety and freedom of sylvan life. The deer ran wild in the thickets of Arden, and the plays show how skilled he was in the whole art of venery and how familiar with that "highest franchise of noble and princely pleasure." "Come, shall we go and kill us venison?" says the banished duke in "As You Like It"; and the latest

* Prefaces of "Cromwell" and "Odes and Ballads," 1826.
† "Shakespeare et La Superstition Shakespearienne," 1914.
‡ "King John," Act II. Scene 1.
§ *Ibid.* Act V. Scene 7.

authorities agree in thinking that the traditional story of the poaching affray in Charlecote Park is founded upon fact, and that Sir Thomas Lucy of Charlecote was the prototype of Mr. Justice Shallow. By his rovings through the forest his mind was stored with the lore of park, warren and chase, and the loveliness of country sights and sounds.

His imagination was also fired by the stirring events in the history of his country. Eight miles away stood the lordly castle of Warwick, with all the associations of the great King-maker. The battle of Bosworth Field was fought only eighty years before the poet's birth, and we know how long stories and traditions linger on in the country. Even now in North Oxfordshire the peasants can tell you stories of the Great Civil War, just as if Charles and Cromwell were fighting the other day; so the men whom Shakespeare knew, the farmers and foresters of Arden, would discourse to him of the century-old battle; and if I mistake not his mother, Mary Arden, who was a lady of high degree, laid in his mind the foundation of those historical romances upon which that great series of historical dramas was constructed. To the value of these merely as a study of English history the great writer, Mr. James Gardner, bears abundant witness.

We will visit first the poet's home, the town of Stratford. We must not expect to find in this modern place all that Shakespeare knew and saw. Mr. Halliwell-Phillips, the great Shakespearean scholar, says that with the exception of a few diffused buildings, scarcely one of which is in its original condition, there is no resemblance between the present town and the Shakespearean borough. But some certainly remain. There is the well-known birthplace of the poet. It is one of the two houses in Henley Street purchased by John Shakespeare, his father, in 1575. The whole town in the sixteenth century consisted of these half-timbered, gabled-roofed, wood-and-plaster houses, with gardens at the back and also at the sides; the streets were broad, and took the form of a central cross, and at the intersection stood the High Cross, a solid stone building with steps below and open arches above. There were held the markets. The old bridge built by Sir Hugh Clopton still spans the Avon, and there was another cross in the Rother market, where quantities of cattle were sold—"Rother" being an old Saxon name for horned cattle, and Shakespeare uses it in his play, "Timon of Athens." Then we notice the grand old Gothic buildings that belonged to the Guild of the Holy Cross, consisting of a chapel, hall, grammar school and the almshouses of the ancient guild. This guild was dissolved at the time of the Reformation, but Edward VI. was induced to disgorge some of the spoil and refounded this and other grammar schools. Here the poet received his early education, being thoroughly grounded in Latin; and Sir Sidney Lee has shown by references to the plays how well he knew Ovid, though his scholarly friend, Ben Jonson, declared that he had "small Latin and less Greek." A visit to the large schoolroom makes one picture in imagination the clever, bright, brown-eyed boy sitting at his desk, poring over the "Metamorphoses," Lily's grammar, or writing in the "Old English" script. Across the road stood New Place, the large house purchased by the poet in the days of his affluence in 1597. It was pulled down by Sir John Clopton in 1702, and a fine new house built which was destroyed by Sir Francis Gastrell half a century later. Its site and the garden were purchased in 1876 through the exertions of Mr. Halliwell-Phillips, and placed in the hands of the trustees of the birthplace.

And then there is the stately church, which is much the same as it was in the poet's time. It is partly decorated and partly perpendicular, cruciform, with a handsome tower and octagonal spire, dedicated to the Holy Trinity. John de Stratford in 1332 founded here a chantry, and in 1351 Ralph de Stratford built "a house of square stone" as a college for priests serving the chantry, and the church became a collegiate church. Dean Balshall, in 1465–91, built the noble spacious choir, and in the time of Henry VII. the north and south transepts were added. Opposite the tomb and mural monument we can pay respectful homage to the poet's memory and gaze at his effigy, which the best authorities consider to be an authentic likeness of Shakespeare himself. It was erected by Dr. Hall, who married the poet's daughter, Susannah, and the likeness was taken from a cast. The artist was Gerard Johnson, "tomb-maker," who had a yard near the Globe Theatre. It was originally painted to resemble life, repaired in 1748, painted white in 1793, and repainted in 1861. There has lately been a lengthy correspondence on the subject in the Literary Supplement of the *Times*.

Shakespeare's age was an age of building. He must often have witnessed the masons and carpenters at work. It was an age when so many of our noble English mansions were being erected, an age that gave birth to Hatfield, Longleat, Audley End, Chatsworth, Hardwick,

and many other of the grandest English seats. It was an age of great architects: of John Thorpe (whose designs you may still study preserved in the Soane Museum, or better still in some of his masterpieces), of Bernard Adams, Bradshaw and Huntingdon Smithson. You will remember the poet's words—

> When we mean to build,
> We first survey the plot, then draw the model,
> And when we see the figure of the house,
> Then must we rate the cost of the erection,
> Which if we find outweighs ability
> What do we then, we draw anew the model
> In fewer offices, or, at least, desist
> To build at all.

All the country squires, the newly-enriched city merchants, or the *nouveaux riches* who had enriched themselves with the spoils of the monasteries, or been blown by lucky gales into the sunshine of Court favour—all these were building: some great palaces such as Wollaton, or Burghley House, or Longleat, others those charming manor houses that stud the countryside, set in a framework of dark trees in sequestered villages and obscure hamlets. Such a house is South Wraxall Manor House, erected originally by Robert Long about 1440. The present great hall, porch, kitchens and withdrawing room date from that period; but Sir Thomas Long followed the fashion of his age in the sixteenth century, and set to work to build the gateway with oriel and porter's lodge, and in Elizabethan and Early Jacobean times many alterations were made. You will admire these entrance gates with the view of the house beyond.

The builders of these houses were animated by the same spirit which moved Sir William Temple, cultured diplomatist, philosopher and garden lover, to write: "The greatest advantages men have by riches are, to give, to build, to plant and make pleasant scenes." And certainly they showed by their buildings that they were men of taste and refinement, very different from Macaulay's unflattering picture of the old English country squire, who is represented as an ignorant boor. It is not in the greatest mansions, the vast piles erected by the great nobles of the Court, enriched by the plunder of the monasteries, that we find such artistic perfections, but most often in the smaller manor houses of the knights and squires. These are the buildings which delight us, the charms of which we are attempting to set forth. The great noblemen and courtiers were filled with the desire for extravagant display, and erected such clumsy piles as Wollaton and Burghley House, importing Flemish and German artisans to load them with bastard Italian Renaissance detail. Nothing could be worse than some of these vast structures, with their distorted gables, their chaotic proportions and their crazy interpretation of classic orders. Contrast these vast piles with the typical Tudor manor house, the means of the builders of which, or their good taste, would not permit of such a profusion of these architectural luxuries, and you will discover the far greater attractiveness of the humbler dwelling. It is unequalled in its combination of stateliness with homeliness, in its expression of the manner of life of the men who built it.

These men built not only for themselves but for their sons and grandsons. They lighted what Ruskin calls the Sixth Lamp of Architecture, the Lamp of Memory, and considered it an evil sign of a people for houses to be built to last for one generation only. They felt that "having spent their lives happily and honourably, they would be grieved, at the close of them, to think that the plan of their earthly abode, which had seen, and seemed almost to sympathise in all their honour, their gladness or their suffering—that this, with all the record it bare of them, and all of material things that they had loved and ruled over, and set the stamp of themselves upon—was to be swept away, as soon as there was room made for them in the grave; that no respect was to be shown to it, no affection felt for it, no good to be drawn from it by their children; that though there was a monument in the church, there was no warm monument in the hearth and house to them; that all that they had ever treasured was despised, and the places that had sheltered and comforted them were dragged down to the dust. I say that a good man would fear this; and that, far more, a good son, a noble descendant, would fear doing this to his father's house . . . When men do not love their hearths, nor reverence their thresholds, it is a sign that they have dishonoured both . . . Our God is a household God as well as a heavenly one; He has an altar in every man's dwelling; let men look to it when they rend it lightly and pour out its ashes."

Such feelings seem to have animated the builders of the gems of domestic architecture that adorn our countryside. They stamped their impress on the homes they reared. They expected their children to respect their gift to their families. They carved their names or their initials or their arms over their doorways. They adorned them with texts or homely verse, pious thoughts, or quaint or humorous conceits. They built surely and well so that their houses might last, not for their own pleasure nor for their

own use, but for their descendants, who would thus venerate the hand that laid those stones and respect the memory of their forefathers and the honour of their house.

The view on the screen is Grimshall Hall, in the favoured shire of Warwick, which, perhaps, Shakespeare saw being built. It must have been just about his time. It is a delightful timber and plaster house with projecting porch, shallow bay windows supported by brackets, and brick clustered chimneys. You will doubtless, be acquainted with the usual plan of a manor house of this period, called Tudor or Elizabethan—the kind of house in which the poet lived in the days of his affluence. He seems to have liked a manor. He even joked about it. Costard and Biron are speaking in "Love's Labour's Lost." Costard says—

> The matter is to me, sir, as concerning Jacquenetta. The manner of it is, I was taken with the manner.
>
> BIRON: In what manner?
>
> COSTARD: In manner and form following, sir. . . . I was seen with her in the manor house, sitting with her upon the form, and taken following her into the park; which, put together, is, in manner and form following . . .

—and so on with his jesting, which, perhaps, seems a little forced to the admirers of modern humour and Mr. Bernard Shaw.

They were usually E-shaped, a pleasing but altogether fictitious fancy associating them with the name of Queen Elizabeth. That porch has a story to tell.

The old English squire loved to dispense hospitality and to give warm welcome to his friends. The door was a symbol of hospitality. There he welcomed their arrival; there he speeded his departing guests. He loved to make the entrance to his house fair and pleasant to the eye. From the steps he greeted his tenantry when they came to congratulate him on some happy event in his domestic life, or to condole with him in his sorrows; and there in the proudest moment of his life he stood to present his young son on the youth's coming of age, happy that the old line had not died out and that his son would maintain the honour of the family and carry on its old traditions. The porch and doorway were associated with many happy comings and goings, and some sad ones, too. It held a place of honour in the old manor house. Originally it was quite small and insignificant, a simple covering to protect those who knocked for entrance. Over the door the squire placed his coat-of-arms with mantlings, crest, and supporters—

> Two of the first, like coats of heraldry, due but to one and crowned with our crest.—"Midsummer Night's Dream."

The porch was increased in size with a chamber over it, and it became an important feature of the Tudor house. Completing the plan of an E-shaped house you would notice the four-centred arch and the Tudor dripstone, which are characteristic of the style. Through the porch you entered the screens, and on the left saw two or more uncovered entrances to the hall, and on the right the buttery hatch. As Maria says to Sir Andrew Ague-Cheek—

> Bring your hand to the buttery-bar, and let it drink.

We pass on into the hall, which remained for a long period the traditional plan of manor-house building, until the Italian style doomed its suppression. This large room with a dais at one end was the principal chamber in the house, where the family dined at the high table, and the retainers and servants in the body of the hall on trestle tables. A fire burned in an open hearth or in a huge fireplace with dog-grate. You remember when Capulet cries out—

> A hall! a hall! give room and foot it, girls.
> More light, ye knaves; and turn the tables up,
> And quench the fire, the room is grown too hot.

Mention is also made in the same place of the great chamber, the Elizabethan gallery, which is a beautiful feature of a house of the period. The bay window of the hall always marks the dais end, and betrays the original plan of the house, even after the hall has been robbed of its dignity and cut up into rooms and passages. The wings show the increased desire for comfort in Elizabethan times and provided greater room for retirement and privacy. Lattice windows had come into use in the poet's time. You will remember that he speaks in "All's Well"—

> So my good window of lattice, fare thee well.

Ufton Court, in Berkshire, is a fine old manor house. The kitchen is older than Shakespeare's time, but the main portion was built by Elizabeth, widow of Sir John Mervyn, who married Richard Perkyns in 1568, and has endured subsequent restorations. When Shakespeare was a child this house was mainly built, and was subsequently the home of Arabella Fermon, the reigning beauty of Queen Anne's day, the heroine of Pope's "The Rape of the Lock." The Perkyns were recusants, and there are two ingenious priests' hiding-holes. You would find

the hall with its minstrels' gallery, a fine room with stucco ceiling and pendants, black-and-white marble floor (1570), wherein Lady Mervyn's charitable gifts of bread, flannel, and calico are still distributed every Mid-Lent Sunday.

Ockwells (Berks) is another very interesting house, built by Sir John Norris in 1466, the heraldic glass being particularly important, showing the arms of the patrons, friends, and connections of the owner. Here is another view of the house as it was in Stuart or Elizabethan times, with a goodly company of guests issuing from its hospitable doors.

In any account of the buildings, whether manor houses, churches, or cottages, geology must play its part. I venture to exhibit a map of England showing the places where good building-stone was plentiful, where wood and forests yielded materials for the beautiful half-timber houses, where chalk and flint were found. Warwickshire had excellent building-stone and also good timber. I have already shown views of the early home of the poet, the school he attended, and other homes at Stratford which were of the good half-timber construction, with their projecting upper storeys and tiled roofs. The nearness of the upright timbers together is a sign of their construction, early in the sixteenth century. Later on we find, when timber was getting scarcer, that the timbers were placed farther apart, and curved braces came into fashion. Here are some examples of manor houses of this mode of building.

Cheshire is very celebrated for its "magpies." This word is given in Shakespeare, I think—perhaps some Shakespearean scholar will correct me if I am wrong—as "magot pies"—

> Augurs and understood relations, have by magot pies, and choughs and rooks, brought forth the secret'st man of blood

occurs in "Macbeth." These Cheshire magpies are not birds, but houses that take their name from the black-and-white plumage of the bird of omen.

Here is Prestbury, Cheshire; and here is Handford Hall, a delightful magpie, rich in beauty and romance. The Handfords of Handford were a sturdy race, like many of the other old families of Cheshire—

> Strong in the arm
> And weak in head.

One fought in the Crusades and took for his cognisance a wondrous star that fell from heaven before the armies of Saladin. Another fought in France against Jeanne d'Arc, and the last of the heirs-male fell fighting against the Scots at Cheviot Moor. He left a daughter, Margaret, who married first Sir John Stanley, the warrior sung by Sir Walter Scott, who quarrelled with the Leghs and became a monk, and, secondly, Uryan Brereton, who built the present hall surely and well, and the grand old staircase and panelling bear witness to his skill and a hiding-hole in the stairs to his ingenuity.

I do not know whether Shakespeare ever journeyed northwards and saw the Yorkshireman's rugged dwelling. He certainly was at York during one of his players' pilgrimages, and may have seen the lonely Cartledge Hall, far from the haunts of men, a manor house of the late fifteenth or early sixteenth century. Few people know of the existence of this. It is built throughout of large blocks of stone, and has the typical large stone slabs common to the district. It stands solitary and alone, exposed to the fierce storms that sweep over a wild, bleak, and rugged moor, challenging the fury of the tempestuous gales.

There is not much to tell of the history of these houses. They have passed through the ages peacefully and pleasantly. History fails to record any great events that happened in these ancestral halls or disturbed their placid existence. Plots and conspiracies could not be bred in such quiet homes, and if an occasional secret hiding-place tells of dangers feared or actually realised the page of history is silent. They resemble closely their owners, sturdy country squires who hunted and sported, farmed and tried to do their duty to their neighbours, and then slept in the neighbouring churchyard where a simple stone slab records their names and memories.

Not entirely without history, however, is the hall of Eyam. It is connected with the theatre, as the plague was conveyed to the village in some stage dresses that were sent there from London for the purpose of a masquerade.

Shakespeare was more familiar with brick-built dwellings, and I will show you a grand example, once the residence of another poet, George Crabbe, who loved Sarah Elmy, niece of John Tovell, farmer, who lived then at Parham Old Hall, the home of the Willoughbys, a very perfect example of brick building, and certainly one of the most picturesque. It was never a very great house, and is now a somewhat decayed farmhouse. It rises sheer out of its broad tree-girt moat, its walls of rich red where the bricks are crumbling, of green and grey and yellow where

they are overspread with moss and lichens. It was built by Sir Christopher de Parham, father of the first Lord Willoughby de Parham, between the years 1498 and 1527. The house has shrunk somewhat since then, and has lost some of its ancient features. It is a pity that no friendly hand can be outstretched to restore it to its former greatness.

Other brick houses I may mention are Wickenbeaux, Kent, the crowsteps of which are a sign of Flemish work. Flemish influence greatly increased in Shakespeare's day. Three years before his birth the immigration began from Flanders, the Flemings bringing with them their looms and the secrets of their trade of cloth-making. Colonies of Flemings settled in various parts of the country, chiefly in Kent, Surrey and East Anglia, where their fellow-countrymen were already established, and wherever they settled they left evidence of their presence in their buildings, their curved gables, crowsteps and other peculiarities. Preston-on-Stour has some remarkable clipped yews, which recall the line—

> Slips of yew silvered in the moon's eclipse,

and I exhibit a view of Ickham, Kent.

When we try to realise the aspect of the country as it was in the poet's time, we must remember that not only was his era an age of great building operations, but that England was then a land of ruins. Scattered over the country were the ruins of the great abbeys, priories, nunneries and other monastic buildings. When Shakespeare was a young man scarcely fifty years had elapsed since these magnificent piles had been shorn of their glory, some converted into dwelling-houses for the rich men who had profited by their dissolution, others with lead torn from their roofs, faced stone stripped from the thin walls, pictures of desolation and of the merciless fury of the iconoclast.

> The ruin speaks, that sometime it was a worthy
> building.

Here is a view of Netley Abbey, picturesque in its decay. The ruin was not so complete in the poet's day. Time's rude hand has further left its mark on the deserted sanctuary, and the greed of men through the centuries has pillaged its stones; and houses, bridges and churches have been reared from monastic ruins. One abbey of Reading, one of the grandest in England, sent its stones to renovate and build parts of Windsor Castle.

Perhaps he had in his eye a picture of a ruined house when he made Valerian say in "Two Gentlemen of Verona"—

> O thou, that dost inhabit in my breast,
> Leave not the mansion so long tenantless,
> Lest, growing ruinous, the building fall,
> And leave no memory of what it was.

Other ruins there were too. Bolingbroke bids us—

> Go to the rude ribs of that ancient castle;
> Through brazen trumpet send the breath of parle
> Into his ruin'd ears.

That was Flint Castle, where the second Richard lay. All over the countryside were such relics of feudalism with their embattled walls and high towering keeps. Berkeley Castle was standing then, as now, and is often referred to in the play "Richard II."—

> There stands the castle by yon tuft of trees,
> Mann'd with 300 men.

Kenilworth Castle was then in its prime, and readers of Sir Walter Scott will remember the amusing pageants that took place there on the occasion of the visit of Queen Elizabeth. Sudeley Castle also saw a similar pageant and masque, and still exists to tell us of the past. You will remember the touching scene at Kimbolton Castle in "Henry VIII.," and the vision of the injured Queen Katherine. Scenes are laid at Pomfret, Baynard's Castle, Middleham (Yorks). Very many have been destroyed since then. In the contest between King and Parliament, which burst forth in less than thirty years after the poet's death, many entered upon their last life-struggle. They were principally owned by Royalist gentlemen, who strengthened their defences and held them for their king. They endured long sieges and were thorns in Cromwell's side. When he triumphed, lest these strongholds of the malignants should again trouble him, he ordered them to be "slighted," their fortifications levelled with the ground, and their power crushed. Here is a view of a very gallant little castle, Donnington, of the Edwardian type, oblong in plan, with four curtain walls and towers at each corner. This is associated with another poet, with Chaucer, the father of English song, as it was held by Thomas Chaucer, who is, I believe, usually deemed to have been his son. It underwent a very gallant siege during the Civil War, and was held by a brave soldier, Colonel Boys, who maintained it during the whole war. Cromwell brought against it the full force of his battalions. It endured siege after siege, but never yielded until the king's cause was hopeless. Having been ordered to abandon Donnington, Colonel Boys

and his gallant men marched out with their arms, their flags flying and drums beating, having earned the respect of both friend and foe.

In the bailey court of these castles, then many of them little the worse for wear, and in the quadrangles of the mansions, were held brilliant pageants; at the embayed window the gay rhymer wrote his pastoral, or the daintily-ruffed lady read her Plato; on the terrace the moonbeams slept as gaily-dressed courtier and romantic maiden whispered their vows; in the dining-hall, with its timber roof, its rows of armour, swords and battle-axes, dark with blood-stains, the old soldier told his stories of wars in Ireland, the Netherlands or the Welsh marches; by the massive fireplace in the ladies' room, with its piled logs and brass furniture, the ancient dowager sat in winter, whilst the wind lifted the tapestries and hurried up the chimney like a moaning, muttering spirit; in the park there was room for hawking and hunting, for tilts, and even for duels. I should like to tell you of the furniture and contents of these houses, but my remarks must be brief. Many were enriched with the spoils of the monasteries. Froude has a fine passage on that subject. Shakespeare speaks occasionally of tapestry, though some of it was "worm-eaten," in "Much Ado About Nothing." Some he tells us was imported from Turkey, and Gremio was proud of his Tyrian tapestry, as well as of his cypress chests, his arras counterpoints, his fine linen, Turkish cushions bossed with pearl, his Venetian valence, his pewter and brass vessels which had taken the place of wooden platters. The heavy four-posted beds, in which, of course, Queen Elizabeth is sure to have slept, and tables and chairs of the period are not uncommon, and can still be seen in many old houses or collections of old furniture. Parts of the quadrangle, when there was only one, and the whole of a separate one when there were two, were taken up with kitchens, pantries, and store-houses. And then there was the garden, sometimes of many acres—a world of shady avenues, of espaliers, of clipped yews, of smooth lawns, of brilliant aviaries, of classic figures, of snug summer-houses, of ponds for goldfish, of cool and splashing fountains. "God Almighty first planted a garden," said Lord Bacon, with pious fervour, and when Laneham had seen the glories of Kenilworth Castle, its fruits, flowers, birds, fishes and trees, he said that "it was not so good as Paradise, for want of the fair rivers, yet it was better a great deal by lack of so unhappy a tree."

The poet's eye must often have rejoiced in the old gardens that were attached to the houses that he saw, and the poet's tongue loved to sing of the fair flowers they contained. The flowers of Shakespeare have formed the subject of a well-written book, and the garden at Stratford containing all his flowers will be known to you. Many a scene in the plays occurs in a garden. You will remember Leonato's garden in "Much Ado About Nothing," especially as it was represented on the old Lyceum stage when Sir Henry Irving and Miss Ellen Terry played so charmingly Benedict and Beatrice. There is that Duke of York's garden at Langley in "Richard II.," where the gardener gives directions for binding up—

> . . . Yon dangling apricocks,
> Which, like unruly children, make their sire
> Stoop with oppression of their prodigal weight;

and where the poor young queen hears of the deposition of the king, and when she dropped a tear the faithful gardener resolves to—

> Set a bank of rue, sour herb of grace:
> Rue, even for ruth, here shortly shall be seen,
> In the remembrance of a weeping queen.

The formal garden was coming into vogue. The name of Bacon is hazardous in Shakespearean circles, but I may mention Bacon's essay on gardens as affording a description of the style then in vogue. The poet speaks in the above-mentioned play of "a curious knotted garden," and here is a view of the style of gardening that was coming into fashion, the formal garden which Capability Brown and his imitators, in their quest for Nature, so wilfully and absurdly wrecked.

This old walled garden at Groombridge would have pleased the poet's eye. Or this Italian style of Renaissance art, with its yew hedge and terrace steps and statues.

The garden at Boscobel based on its formal lines is attractive, a garden that was destined soon after the poet's days to welcome its royal guest during those strange wanderings after the fatal fight at Worcester until the bark at Shoreham conveyed the youthful Prince to the shores of France.

Shakespeare sings sweetly of many flowers—of lilies, of carnations and streak'd gilliflowers, the fairest flowers of the season, that some call nature's bastards; of rosemary and rue, these keep seeming and savour all the winter long: of morning roses newly washed with dew; and here all old-fashioned flow'rets seem to grow—it is the garden of the Deanery at Rochester,

where lived that great garden-lover, Dean Hole.

But let us take leave of the country for a moment. As we pass from Warwickshire to London, or up and down the island, we meet with several towns and see them girt with strong walls, memorials of the gradual growth of the merchant cities, the progress of trade, and its triumphs over the powers of the barons and mediæval feudalism. Shakespeare often saw the walls of Coventry, now almost disappeared, whereon he placed Scene I., in "Henry VI., Part III."; of Warwick, too, where the town gates still stand to guard the main street. I can show you a few views of the strong walls of Southampton, which the poet saw, first reared in Norman times, and greatly strengthened in 1352 during the Hundred Years' War, after an attack of the French, which our Elizabethan Stow so graphically describes. You will remember how he tells of the captain of the pirates, the King of Sicily's son, who was beaten down by a rustic and cried "Rançon, Rançon"; but the rustic knew not the French tongue, and replied: "Yea, I know thee well enough; thou art a Françon, and therefore thou shalt die." So, unaccustomed to take gentlemen prisoners and to keep them for their ransom, he slew the knight. The discoveries of the new world by the gallant seamen of Shakespeare's day, and of the Cape route to the East Indies, deprived the town of its importance. Venice, that "held the gorgeous East in fee," no longer sent her merchant ships to Southampton Water. There was peace with France, and the town walls and castle became mere antiquarian relics, and were so when the poet lived. In the towns of England there was in his time much desolation. In the narrow, tortuous, unhealthy streets plague often stalked, and the people fled. Ruined priories and chantries were plentiful, and we gladly shake off the dust of the towns from our feet and go back to our country.

Here is a view of a picturesque yeoman's farmstead, such an one as Bishop Latimer described when he told of his father's home and household; and such an one as Richard Shakespeare lived in, with his son John, before the latter migrated to Stratford.

As Shakespeare journeyed from Stratford to London he would often gaze upon some village or market crosses as this one of Lambourn. There were two such crosses in his native town. No Puritanical iconoclastic zeal had as yet doomed so many of them to destruction; nor had the utilitarian spirit of the eighteenth and nineteenth centuries robbed England of its treasures. Stephano says of his mistress, Portia—

She doth stray about
By holy crosses, where she kneels and prays
For happy wedlock hours.

Here is another example, Shapwick Cross. These village crosses were for divers purposes. I have written about them elsewhere, and it would take too long to describe their uses. They were often placed in the churchyard, whither

Ghosts, wandering here and there, troop homeward,

as we read in the "Midsummer Night's Dream." And now, "I can see a church by daylight," says some one in "Much Ado About Nothing." The poet often gazed upon these holy shrines, set in every village, with their lofty spires or square tower standing amidst the tall elms, seeming to speak with a living voice proclaiming the stability of English life, the ever-enduring sameness passed on from year to year. There were nearly 10,000 churches in England in Shakespeare's time, and I hope he was, as I expect he was, a regular attendant at some of them. His memory is preserved in Southwark Cathedral, where a monument has been raised to his honour.

I may possibly be able to tell you something that may be new to you, unless you have been so incautious and foolish as to read one of my books which records the incident. I was visiting a friend in Buckinghamshire, at Grendon Underwood, and there I saw the porch where Shakespeare is said to have slept when he was wandering, a poor youth or strolling player, to London. He was disturbed by the village constable, who accused him of having robbed the church. The constable summoned some of the neighbours to help him to hold this terrible robber. The young poet prayed that he might be searched, and when no church goods were found upon him he exclaimed, "Much ado about nothing." The village constable is said to have been the original of Dogberry and Verges. The dialect of the characters in the play is said to be pure Buckinghamshire. Moreover, there is in the village a house known as Shakespeare's Farm, formerly an inn, called The Ship, where the poet is said to have often stayed. Indeed, you are shown the actual bank upon which "the wild thyme grows." All this I have tried to tell elsewhere, and will not trouble you now with any details.

And now we come to the village inn, which Shakespeare knew well, quite as well as the London inns and taverns which he used to frequent in company with the members of his

company of actors and the poets of his day. "Shall I not take mine ease in mine inn?" says Falstaff at the Boar's Head Tavern in Eastcheap. Along the great roads there were famous inns with accommodation for numerous guests, stabling for a hundred horses, and beautiful in their picturesqueness. The ordinary village inn was a hostel such as Izaak Walton loved to describe, "an honest alehouse where we shall find a cleanly room, lavender in the windows, and twenty ballads stuck about the wall, where the linen looks white and smells of lavender, and a hostess cleanly, handsome and civil." The great coaching days had not yet dawned. The "Mercury," the "Regulator" and the "Lightning" had not yet begun their adventurous careers. Not until 1667 did the "Flying Machine" run from London to Bath in three days (if God permit—as the pious poster announced). But travellers were numerous and inns plentiful, with their red-tiled roofs, the deep bay-window, the swinging sign-board, the huge horse-trough, the pump and outdoor settle; while within the old-fashioned fireplace with seats on each side in the ingle-nook, and the blazing log fire in the dog-grate, were cheering sights to the weary traveller. The sign-board that swings outside the inn has many stories to tell as it creaks in the wind. Some of these signs are remarkable for the exquisite ironwork that supports them, and tells of the skill of the village blacksmith of former days. The man who forged such beautiful specimens of ironwork had the heart and mind and hand of the true artist, though he was but a village smith. The signs, too, at least of the old ones, are well painted. A favourite Tudor sign was The Bull and Mouth, a corruption of Boulogne Mouth, or harbour, captured by Henry VIII. from the French. The Angel, at Grantham, The Bell, at Stilton, will occur to the minds of many students of old inns. Shakespeare would have met in his journeys a strange mixture of characters in these hostelries. The nobleman with a small army of retainers carrying half of his furniture with him as he moved from one of his seats to another; the knight of the shire, or the burgess of a town on his way to London to attend Parliament, spending his allowance of 2*s*. a day and expenses (members were paid something in those days, it appears—a practice which has now been revived); the poor scholar on his way to Oxford or the Temple, his cob and himself a compound of leanness and learning; a bishop and his chaplains, a highwayman, wounded soldiers, romancing sailors, musical tinkers and weary foot-passengers, paying a penny a night for their beds. Many scenes of this kind must Shakespeare have witnessed at Stratford, as the traffic stayed there between Oxford and Birmingham.

The view before you is called Ye Old Corner Cupboard, at Winchcombe, Gloucestershire, a fine inn of the smaller type, in the region of good building-stone, of Gothic design, the style of which lingered on in the West Country for some time after the mediæval period, and, indeed, is not yet dead.

Here is a view of another noted inn—The Bell, at Hurley—an old coaching inn of the fifteenth century on the road from London to Oxford. And we may just look (as we are here) at the Hurley Tithe Barn, a familiar object in Shakespeare's time. It belonged to the old Hurley Priory, which still stands with its neighbouring dovecotes.

It was within the yards of the great inns in country towns that plays were performed, the galleries running around the yard forming admirable places for watching the players. Few of these galleried inns remain, and several have disappeared from London within recent memory. In London the principal hostels used as primitive theatres were Bel Sauvage in Ludgate Hill; The Bell and the Crosskeys, in Gracechurch Street; The Bull, in Bishopsgate; and The Boar's Head, in Eastcheap.

The village shop in the poet's day, I expect, supplied the endless assortment of goods which still characterises our modern rustic emporiums, where you can get anything from a bootlace to a side of bacon. There is one at Lingfield, in Surrey, which has performed its useful mission since the fifteenth century. It has a central recess with braces to support the roof-plate. Formerly there was an open shop-front with wooden shutters hinged at the bottom of the sills, on the tops of the stall-boards, and which could be turned in the daytime at right angles with the front and used for displaying wares. In some cases there were two shutters, the lower hinged in the bottom sill, as I have described, while the upper was hinged to the top, and, when raised, formed a pent-house roof. Shakespeare alludes to this arrangement when he says, in "Love's Labour's Lost"—

> With your hat pent-house like o'er the shop of
> your eyes.

And now I must show you some examples of old cottages. There is a sad contrast between the unsightly modern cottages, with their

glaring brick walls, their slate roofs, their little ungainly stunted chimneys, and the old-fashioned thatched or tiled dwellings that form so charming a feature of English rural scenery, and must have delighted the poet's eye.

It is a small house of odd, irregular form with various harmonious colouring, the effects of weather, time, and accident, the whole environed with smiling verdure, having a contented, cheerful, inviting aspect, and a door open to receive a gossip neighbour or weary exhausted traveller. Such is a cottage which the poet and the painter loves, a type which is happily not extinct in modern England—

Its roof, with reeds and mosses covered o'er,
And honeysuckles climbing round the door,
While mantling vines along its walls are spread,
And clustering ivy decks the chimney head.

In the construction of timber-framed houses we noticed the use of wattle and daub for the filling up of the panels formed by the horizontal and vertical timbers. The builders of our old houses were not content to leave the surface plain and unadorned. The panels pleaded for decoration. In many cases the whole of the surface of the walls was plastered over, and this afforded a wide field for the plasterer's art, and he did not fail to make extensive use of it. His art was called pargeting or parge-work.

We give an interesting example of external parge-work in the house at Newport called the Crown House, which tradition says was inhabited by the fascinating Nell Gwynne, who died in 1687. The date 1692, which appears on the house, probably refers to its restoration and to the erection of the porch. The plaster-work is excellent, but it is being sadly worn by the severity of the English climate.

I have consumed so much of your time in describing the kind of houses that Shakespeare knew that I have left little for the recording of village life and character. We can see the old squire in his manor house, a very interesting person. You must not take as gospel truth all that Macaulay says about him. He was by no means the ignorant boor such as the historian, to his own disgrace, painted him. He was fairly learned and knew Latin, perhaps, better than the ordinary country gentleman of to-day. He had travelled abroad. He went to London once a year and purchased books. He discharged his duties as a magistrate with good common-sense, aided by a little law. His amusements were chiefly hunting and hawking. He was not troubled with that absurd gambling spirit which a century and a half later caused the ruin of so many of his class. One squire gambled away his house room by room, and when it was pulled down gambled away the bricks. Another lost his house and estate through gambling and hanged himself in an attic, and his ghost haunts the house in revenge, because his widow married the man who had won all his money. The Elizabethan squire was not so foolish. He liked a quiet game at bowls in the evenings on his well-kept green, and could appreciate poetry. I expect he looked down with scorn on the new fashion, which had just set in, of smoking tobacco—a dislike which probably the poet shared, as he never mentions it. His wife and daughters attended to the wants of the villagers, performed the usual household duties, did needlework, and played on the virginal. And cards and draughts, dice and dancing were indulged in—the old country dances, which are not really country dances, but *contré* dances, the partners standing opposite each other as in Sir Roger de Coverley. But we have not time to discuss Elizabethan dancing, or, perhaps, some of the ladies might kindly demonstrate how to dance the canary, or the brawl, or help us to realise Beatrice's description of the pavin.

I have no time to tell of rural sports, of cock-fighting, archery (which was going out of fashion), of church-ales, fairs, football, and much else.

Our Berkshire registers of this period tell of a terrible event at North Mouton during a football match in Shakespeare's time in 1598, and shows that the game was rough and fast and furious. The poet bears witness to the same fact. Lear says to the steward—

Do you bandy looks with me, you rascal? (*Strikes him.*)

STEWARD: I'll not be struck, my lord.

EARL OF KENT: Nor tripped, neither, you base football player (*tripping up his heels.*)

Tripping is not considered quite legitimate play in modern football.

This register records the burial of two men, Richard and John Gregorie, and states: "These two men were killed by ould Gunter. Gunter's sonnes and the Gregories fell together by ye yeares (ears) at football. Ould Gunter drew his dagger and broke both their heads, and they died both within a fortnight after." Sad to relate, old Gunter was the parson of the parish. Possibly he was witnessing the savage game. His sons and the Gregories were playing fiercely in the scrum. He saw his boys overthrown by their opponents and, fearing for their lives and carried away by excitement, drew his dagger, and struck the fatal blows. Strange to say, he was

not hanged, or deprived of his living, or even tried for manslaughter. But this is a curious revelation of the fierceness of Elizabethan football.

Parish registers, recording the short and simple annals of the poor, are full of interest. Here is a page from the Ruscombe register written twenty-six years after the poet's death. It is the only record of a skirmish fought near the village during the Civil War, wherein is mentioned the burial of several soldiers. Here is another page two years later.

Briefs are mentioned in Shakespeare, I believe they were a mode of collecting money for divers good purposes. If a fire destroyed a village or a storm damaged shipping, or other misfortunes occurred, a brief was issued by authority and collections made in churches throughout the land.

Here is a page of briefs of the seventeenth century. Amongst them is one for the redemption of captives taken by the Turks or Mediterranean pirates, who cruelly tortured their victims.

Here is a picture taken from a contemporary print of the kind of tortures inflicted upon their poor captives, from which the alms of the charitable were intended to rescue them.

In "Comedy of Errors" we read of—

> Tartar limbo worse than hell,

and in the "Merchant of Venice"—

> From stubborn Turks and Tartars never trained
> to offices of tender courtesy.

We, too, in England had some tortures for the unfortunate or the criminal. Punishments, like sports, in the poet's time, were cruel. You might have seen in London a poor baker dragged on a hurdle through the streets for making bad bread. In the country we had our stocks. Shakespeare often alludes to them. Falstaff complains—

> The knave constable had set me in the stocks.

In "All's Well" a victim is said to have been set in the stocks all night; and other passages are doubtless familiar to you.

In one play someone says, "Fetch hither the stocks," showing that portable stocks were sometimes used. These are at Odiham, Hants. Another view.

An accompaniment to the stocks was the whipping-post, which was in frequent use. There were many beggars and poor souls in Shakespeare's time, the result of the dissolution of the monasteries, who were the tramps of the day, and caused as much trouble as do the modern variety. But the authorities of those days had a summary method of procedure, and ordered the tramps to be whipped. Sometimes they consoled the sufferers (as at Hungerford) by giving them some money.

Ducking-stools and branks were much in vogue for scolding women, and here is a view of the latter terrible implement of torture which poor women had to endure who had dared to protest against the vagaries of drunken or faithless husbands, or to speak their minds to a local tyrant dressed in the apparel of a brief authority.

All these were going merrily in Shakespeare's time. The poet loved all the familiar scenes and joyous customs of the country, and doubtless took his part in them in his youthful days. You will remember the humours of the sheep-shearing festival in "The Winter's Tale." People are uncertain as to what period of our history may be assigned the epithet of "merry." Our Chairman, I know, takes rather a gloomy view of the Elizabethan time, but there seems to have been much gaiety in rural England. There were the festivals of Christmas and New Year, of Easter and Whitsuntide, the May Day revels, the pageants of Whitsuntide, the beating of bounds during Rogationtide; and Shakespeare would often go to Coventry and see there the famous pageants, processions, and plays, mysteries and moralities, while strolling companies of players used to roam the country, as Shakespeare himself did. He was probably first attracted to the stage by the playing of certain companies of actors at Stratford in his youth. Probably the Coventry players may have provided him with models for Bottom and his companions, as their playing was rather ridiculous, and caused the Queen to exclaim, "What fools ye Coventry folk are!"

Such were some of the characteristic features of Shakespeare's England. I have not touched upon the London of his day. That is too large a subject for this lecture, and would require a whole lecture or volume for a complete survey. Moreover, it has been well described by Mr. Ordish, in my two volumes of "Memorials of Old London," and by other writers. The trade and commerce of the period, the development of England's sea-power, which has ever held its sway from the time when England overthrew the Invincible Armada to the present day, and has proved itself the salvation of our country and the chief factor in our present world-wide war; the Court, the drama, and the literature of the time; the religious controversies and the contending factions of Protestant, Roman

Catholic, Puritan: all these I have been obliged to omit from this sketch of the England of Shakespeare.

I have tried to conduct you along the broad highway, the country roads of rural England, where traces are still left of the England Shakespeare knew, to linger at the village inn, the manor house and humble cottage, to see the rustics at their sports and merry-makings, and if I have lingered too long on special features and omitted others, the fault must be partly attributed to the limitations of an illustrated lecture and to the special predilections of the lecturer—a fault that I hope to amend when the book which I am now engaged upon sees the light.

As far as circumstances will allow during the coming celebrations of the poet's death we shall try to study anew the life, work, and character of our national bard; and if we would do that we must place him in his Elizabethan setting and cast our thoughts back three hundred years and more, to live in his time, and know the manners of his age. Students of his works, Shakesperean scholars, who can analyse each play and who revel in the perplexing meanings of divers words and passages, in his allusions and problems of language, in his sources of knowledge, and the origins of his plays, in divers readings in the classification or chronology of his works, and such-like questionings, may scorn the humbler task. But it is no less important. The jewel gleams in the sunlight, but its setting adds to its beauty.

Shakespeare sent forth a burning message for all time of ardent patriotism and love of England. It is not without signification that his death-day falls on the Feast of St. George, England's patron saint, whose name was the battle-cry of our warriors in many a bloody field. It was "the ancient word of courage, fair Saint George"* that inspired "our men with the spleen of fiery dragons."† May we, in this modern Armageddon, sound forth the same encouraging cry (slightly modified): "God and Saint George, England and victory."†

THE CHAIRMAN (Mr. Hubert Hall), in moving a vote of thanks to the author, said the paper was a most interesting and instructive one. There were many aspects of the subject and many methods of study, and it was clear that the author set out with the special object of placing before the audience the England of Shakespeare based on his great knowledge of archæology. The occasion —the approaching tercentenary of the death of the poet—was an appropriate one. There were a great many records in existence, most of them of native origin; but there were also sources of foreign origin, and he was rather surprised that two or three of these descriptions of Elizabethan England had been lost sight of in recent years. He had been very much struck by the shrewd observations of foreign travellers, particularly a German, Leopold von Wedel, of Stettin. This MS. was discovered by the British Consul at Stettin, who sent a transcript to England. The German traveller appeared to have seen everything at the Court of Elizabeth in 1554-55: he saw the Tower lions; a prize fight before the Lord Mayor and the City Fathers and the citizens, in which the combatants fought with a kind of cestus, and were described as brawny men, well trained. He saw Whitehall, Hampton Court, Sir Walter Raleigh, and Parliament, and recorded a speech by the Queen at the opening of a session. Von Wedel also went to Scotland and made some very interesting remarks about the Scottish nation. There were probably many other descriptions of England which would serve to check the accounts of writers like Harrison and others. Another source which might be explored was the household accounts and diaries, many of which must still be buried in country houses. He remembered the diary of Lady Hobey, an English gentlewoman of very wide knowledge of politics and great ability in conducting her husband's business, a diary which was transcribed by a lady of the Royal Historical Society. No doubt many such diaries had escaped the researches of the Historical Manuscripts Commission.

The motion was carried unanimously and the meeting then concluded.

* "Richard III.," Act V. Scene 3. † *Ibid.*

PARTITION AND CONSOLIDATION OF HOLDINGS IN THE PUNJAB.

Probably the greatest hindrance to the progress of agriculture which is ever encountered in any country is the holding of land in common as the joint property of a village or of a family. Sooner or later, in the Old World at least, in one country after another the problem of the partition of the land into individual holdings has to be faced. But a few years ago it was Russia which was forced to free the land from the hold of the village community. To-day they are struggling with the problem in India, where the village is perhaps more highly developed than it has ever been in any other country, but where, for good or evil, the British administrators have encouraged individual ownership.

In the October number of the *Monthly Bulletin of Economic and Social Intelligence*, Sir James Douie writes with the weight of authority upon the subject of the partition of communal land and the consolidation of scattered holdings in the Punjab.

The Punjab is in the main a country of small

peasant landowners organised in village communities. An ordinary holding in the plains covers from five to ten acres, but the fields composing it do not lie in a single block, but are scattered over a wide area. This happens as the result of a desire to treat each family or subdivision of the tribe to whom the whole area of land belongs with perfect fairness. The land comprised within the area being uneven in quality, it is sought to secure an equitable distribution of the whole by assigning to each family a certain proportion of each kind and quality of land. The disadvantages of such subdivision are obvious, and are sometimes felt so severely as to induce a village community, voluntarily and without official help, to undertake partition of the common land and even consolidation of holdings. When a village has carried out a scheme of partition, and all the necessary exchanges have been effected, particulars of the new holdings may be entered by the village registrar in the mutation register, and, after attestation by a revenue officer, embodied in the record of rights.

It is not often that a friendly settlement of partition transactions can be secured. Usually the proceedings are so complicated that it is considered advisable to invoke the help of a competent revenue officer. The Government in the Punjab has always discouraged the partition of whole villages, but where the shareholders in a joint holding apply to have their interests separated, the law is careful to provide that claims shall be decided by officers of sufficient rank and experience. In Sir James Douie's opinion there is no better test of the worth of a revenue officer than his capacity to deal competently with a complicated partition.

Where there is a real dispute as to title it is necessary to obtain a judicial decision before partition can be carried out. If existing titles are undisputed the right conduct of the proceedings depends mainly upon willingness to take pains. A man dealing with a partition must be prepared to ascertain the real position of the contending parties, to examine all objections brought forward, and where necessary to visit the village and ascertain for himself the truth as to the relative value of different parcels of land. Wherever possible a tenant is permitted to retain land which he has permanently improved, and this may often be made possible by giving to other shareholders a larger share of unimproved land.

The law relating to partition is contained in a chapter of the Punjab Land Revenue Act, but there is no legislation upon the subject of consolidation or "restripement." Necessity has driven the cultivators in some cases to find a remedy for dispersion by exchanging outlying parcels of land, and such arrangements tend to become more common as the system of irrigating land extends in the Punjab. Government now makes it a condition that rectification of field boundaries shall precede the introduction of canal water into a village. Unfortunately, existing orders do not encourage any attempt to add consolidation of holdings to rectification of boundaries. The Indian peasant is intensely conservative, and regards all reforms with suspicion and dislike. It is unwise, therefore, to press them upon him. However, he is quite alive to the advantage of occupying a field of regular shape which can be irrigated rather than one of irregular shape which cannot be irrigated, and he will, little by little, come to appreciate the advantage of having one holding of decent size rather than (as sometimes happens) twelve or even more scattered parcels, whose total area is less than a couple of acres.

MANUFACTURE OF RADIUM IN THE UNITED STATES.

According to an announcement made recently by Mr. Franklin K. Lane, the United States Secretary of the Interior, the production of radium from Colorado carnotite ores by the Bureau of Mines, in connection with the National Radium Institute, has passed the experimental stage in its new process, and is now on a successful manufacturing basis. He also declared that the statements made to Congress concerning the ability of the Bureau of Mines to produce radium at a greatly decreased cost as compared with other processes had actually been accomplished, and that the costs were even less than predicted. From information furnished by Dr. C. L. Parsons, who is in charge of the radium investigations of the Bureau, the cost of one gramme of radium metal produced in the form of bromide during March, April, and May of last year was 36,050 dollars (about £7,210). This includes the cost of ore, insurance, repairs, amortisation allowance for plant and equipment, cost of Bureau of Mines co-operation, and all expenses incident to the production of high-grade radium bromide. When it is considered that radium has been selling for 120,000 dollars (£24,000) and 160,000 dollars (£32,000) a gramme, it will be realised what the Bureau of Mines has accomplished along these lines.

The cost of producing radium in the small experimental plant during the first few months of the Bureau's activities was somewhat higher, but not enough seriously to affect the final average. It should not, however, be inferred that this low cost of production necessarily means an immediate drop in the selling price of radium. The National Radium Institute was fortunate in securing the right to mine ten claims of carnotite ores, and this was practically the only ore available at the time.

Since then new deposits have been opened; but these are closely held, and, according to the best judgment of the experts employed by the Bureau of Mines, the Colorado and Utah fields, which are much richer in radium-bearing ores than any others known, will supply ore for a few years only at the rate of production that obtained when the European War closed down the mines. The

demand for radium will also increase rapidly, for it is stated that the few surgeons who have a sufficient amount of this element to entitle them to speak from experience are obtaining encouraging results in the cure of cancer as their knowledge of its application improves.

The ten carnotite claims being operated at Long Park, Colorado, by the National Radium Institute have already produced over 796 tons of ore, averaging above 2 per cent. uranium oxide. The cost of ore delivered at the radium plant in Denver has averaged 81.30 dollars (about £16 15*s.*) per ton. This included 15 per cent. royalty, salary of Bureau of Mines employees, amortisation of camp and equipment, and all expenses incident to the mining, transportation, grinding, and sampling of the ore.

A concentrating plant for low-grade ores has been erected at the mines, and is successfully recovering material formerly wasted. Grinding and sampling machinery has been installed at Denver, and a radium-extraction plant erected in the same city. The radium plant has now a capacity of three tons a day, having been more than doubled in size during the last twelve months. At first the plant had been run more or less on an experimental scale, although regularly producing radium since June 1914. To July 1st, 1915, slightly over three grammes of radium metal had been obtained in the form of radium barium sulphate, containing over one milligramme of radium to the kilogramme of sulphates. The conversion of the sulphates into chlorides, and the purification of the radium therefrom is easily accomplished and with very small loss of material. Unfortunately, however, special acid-proof enamel ware, obtainable only in France, has not been delivered of sufficient capacity to deal with the crystallisation of the full-plant production, so that a little less than half the output, or, to be exact, 1,804 milligrammes of radium element, have been delivered to the two hospitals connected with the National Radium Institute. The radium remaining can be crystallised at any time from neutral solution in apparatus already installed; but the greater rapidity and efficiency of production of this very valuable material by the methods used have decided the Bureau of Mines to await the completion of apparatus now being built before pushing the chloride crystallisation to full capacity.

The average radium extraction of all ore mined by the National Radium Institute has been over 85 per cent. of the amount present in the ore as determined by actual measurement. The amount present in the ore has been found, in fact, to be essentially the same as the theoretical amount required by the uranium-radium ratio. The extraction figures for the last five car-loads of carnotite treated has shown a recovery of over 90 per cent. in each case.

A bulletin giving details of mining, concentration, and methods of extraction is being prepared by the Bureau of Mines.

ARTS AND CRAFTS.

British Industries at the Victoria and Albert Museum. — The Victoria and Albert Museum appeared in an entirely new light as the home of the British Industries Fair organised by the Board of Trade. The visitor, when he first emerged from the subway into what would ordinarily be the ironwork section, began to wonder where he could be. What under normal circumstances is a spacious corridor was turned into a narrow lane flanked on either side by wooden booths covered, as it seemed at first sight, with teddy bears; and the large courts which debouch from it, though the tapestries on the walls remained and could be seen towering high above the temporary partitions, were filled with stalls displaying stationery, printing, and fancy goods.

It is to be regretted that the authorities did not see their way to holding the exhibition elsewhere. The courts at South Kensington, though spacious enough, are not peculiarly well adapted to shows of this type, and the lack of adequate wall space entirely prevented the display of posters and other large work. Again, the Victoria and Albert Museum is indeed concerned mainly with industrial art and not with fine art, but it stands for art; whilst at the fair, although a certain amount of work of various kinds with some claim to artistic merit was included, the majority of the wares on view were frankly, not to say blatantly, "trady." That the Museum should have been utilised for an exhibition of modern British industrial art would have met with the approval of everyone; to turn it for the nonce into a show place for manufactured toys and nick-nacks of all kinds seems hardly fitting. The industries represented were not very numerous though they covered a good deal of ground. There was a large collection of toys, an almost equally imposing array of fancy goods, and a very fair quantity of printing and stationery, whilst one large court was given up to glass and pottery.

Printing and Stationery.—In the printing and stationery sections a good deal of satisfactory work was to be found, and it comprised not only excellent colour printing of various kinds, but also good examples of type-setting and letterpress printing. In this last division the work of the Oxford University Press stood out, not only for the excellence of the collotype versions of ancient manuscripts, etc., and for the setting-up of books in all sorts of out of the way characters, but also for the printing of more ordinary and simple work. Messrs. George Pulman and Sons, of Thayer Street, showed good reproductions in facsimile colours of Louis Raemaeker's cartoons (Raemaeker's method, of course, of using colour for emphasis, both lends itself to reproduction and makes monochrome renderings rather unsatisfactory), and also examples of tasteful letterpress printing. The Medici Society, of Grafton Street, sent some of their admirable prints in colour from the Old Masters, and a selection of books

published by the Riccardi Press. They were also showing coloured postcards of a number of well-known pictures. These are in an altogether different category from the ordinary German coloured postcards with which we are familiar. They are not highly-coloured daubs caricaturing the originals, on the other hand they err rather on the side of sombreness. They are good efforts in the right direction, but they are not wholly satisfactory. In some respects they are not as good as the earliest productions of a firm in Milan (whose name suggests a possible German origin), who attempted the task of making good coloured postcards from the frescoes and other paintings in the Brera and elsewhere. It is true that the later productions are not (or were not before the war) quite as successful as the earlier ones, but they were still far above the level of the ordinary German work. Their fault lay in a certain want of depth. Before we have an ideal coloured postcard we shall have to obtain a combination of the qualities of the English and Milanese cards. Perhaps when we had achieved it the price of the postcards would be quite prohibitive, and meanwhile the Medici cards are to be welcomed as a very great improvement on the ordinary work. It is to be hoped that after the war, visitors to Italy who want coloured postcards may be offered something more satisfying than the old German wares, and that some of the huge trade in postcards with that country may pass into our hands. Several firms exhibited good examples of work executed by the three-colour process, notably the Photochrome Company of Tonbridge Wells, and most of the best known Christmas card producers sent exhibits. The British Fine Art Company, of South Street, Hammersmith, displayed specimens of a clever process by which not only can oil paintings be reproduced so as to show brush marks in relief and look to the casual observer like the original picture, but watercolours, colour prints, etc., can be so rendered as to give the effect of oil paintings. The result is certainly extraordinarily like oil painting, but whether the ingenuity required to produce a texture to which the reproduction seems to have no particular right, could not have been expended to better purpose is a different question.

Pottery.—There were several interesting exhibits in the pottery section. Amongst these the little show of the Pilkington Tile and Pottery Company, of Clifton Junction, near Manchester, was perhaps the most noteworthy. The large orange-vermilion pots, placed on either side of the entrance, were brilliant pieces of colour which called attention from a distance to a rather small and not particularly well-placed stand. The case of painted lustre in the foreground, though it only contained a few objects, was worthy of the closest attention. The little bowl bought by Her Majesty the Queen was an example of the most exquisitely delicate colouring, the clever model of the child and the cock a specimen of rich and daring colour; the captive slaves, glazed with a beautifully deep lustre, were perhaps a trifle restless and did less justice to the quality of the lustre colour. The Lancastrian ware in the background was good in shape and represented a large range of colourings, and the lustre tiles on the walls suggested the joy of sitting by a fire which would light up such mines of colour. Amongst the firms producing lustre ware must be noted Messrs. Moorcroft, of Burslem, whose matt lustre effects were many of them very satisfactory, and Messrs. Josiah Wedgwood and Son, of Etruria, whose lustred porcelain was very dainty. The broken colour of many of the bowls was very subtle, and the gilt on the outside helped the effect. There is no doubt of the beauty of the work, and yet one feels that there is a certain waste in adding lustre to porcelain. An ordinary earthenware body is not a joy in itself and calls for something beautiful to cover it; fine porcelain, on the other hand, has qualities which are at any rate partially lost under a lustre glaze. Some of the dessert and dinner ware exhibited by the same firm was very satisfactory; the powdered colours were particularly successful, and the adaptation of a Rouen pattern without the unpleasantness of a tin glaze deserves to be popular. The deep orange flambé of the Crown Staffordshire Porcelain Company, Stoke-on-Trent, is remarkable for the quality of its colour. Mr. W. Howson Taylor, of West Smethwick, showed a collection of Ruskin ware, amongst which were some pots giving really fine broken colour effects. Some of the Upchurch ware was also satisfactory, and several firms exhibited pleasing "art pottery," more or less of the peasant type—notably Mr. Barron, of Barnstaple, and Messrs. Brannam, of the same town.

Toys.—The toys on the whole were a trifle disappointing, perhaps because last year's fair had raised rather high hopes. It looked as though innumerable manufacturers were trying to do the same thing, whilst very few were striking out on anything approaching new or original lines. There seemed to be a plethora of "soft goods," especially of teddy bears, all conceived and carried out on very much the same lines. Sloan and Company, of Liverpool, had some quite original beasts and birds, including some truly fascinating geese, and their bedspread with appliquéd animals in the round would not only give joy to any child, but was cleverly and artistically conceived and carried out. Some of the wooden toys were both clever and artistic, and the model villages, Noah's arks and fairy stories exhibited by the Lord Roberts' Memorial Workshops for Disabled Soldiers and Sailors made one long to play with them, and spoke volumes for the controlling spirit of this department of their work. The puzzles of the Aldon Studios, Regent Street, included pictures by such well-known English masters as Walter Crane and Randolph Caldecot, which were not only pretty when put together but eminently fit for puzzles. When, however, one compares the wooden toys and puzzles which we are manufacturing with those which are coming

over in quantities from Japan one cannot but feel that our makers have a very hard task in front of them if they hope to produce as well and cheaply as our Eastern ally. The Japanese toys made expressly for the English market, and as copies more or less exact of European goods, have not the interest of those made by Japanese for Japanese, but they are cheap, and they have very often a definite artistic quality. Nevertheless, it is to be hoped that our toy industry will thrive as never before, and certainly the quantity of British toys shown was very satisfactory. They gave, on the whole, evidence of decidedly more artistic aim than the pre-war toys, but there is still a tendency in certain of them to the rather spooky forms, which are neither beautiful in themselves nor attractive to the average child.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Trade Dislocation.—Complaints of the inability to get delivery of goods within any reasonable limit of time increase, and they promise to go on increasing. The labour, fuel and dyeware shortages which account for most of the delay grow no less severe, and in certain directions congestion has been made the more congested by the impulse to buy well in advance of the requirements of the moment. Estimates of the quantity of machinery standing for want of labour are apt to be misleading, but in a large number of reported cases the proportion is 25 per cent. or more. In these circumstances it need not be surprising that buyers have to grant months where normally they allow weeks for delivery. The outcry is strong while present wants remain unsatisfied, but self-defensive over-buying brings its own reaction later. Meanwhile, the clearing of old and depreciated stocks of goods is assisted, and the necessitous are learning to be thankful for any goods they can be permitted to receive.

Trade Contraction.—Restrictions on the importation of hosiery, silk and lace are expected shortly, and it is understood that the procedure will be by licence. The home production being effectively restricted by other means, it follows that the entire textile trade of the country is to be brought into smaller compass, while the export trade is to be facilitated. The dispensation may be accepted as wise and necessary, although opinion is not unanimous on that score. In any case, the arrangement does not contain much promise of easier prices to the consumer, and it is providential that an unusually large number of consumers are indifferent to the matter of price. The home-distributing business in textiles may be accused of being more sensitive to small influences than to large ones. A trifle like the state of the weather makes more impression than the state of the war, and while this remains the case it dare hardly be professed that the public has got down to the bone of economy in attire.

American Competition.—A significant change in the current of American textile trade has been observed with an unnatural absence of whooping. For the first time in history the United States exports of manufactured textiles have exceeded the imports. The records are a little belated, covering eleven months of last year, and omitting account of subsequent movements which almost certainly accentuate the contrast. The improvement is accepted fatalistically in America as an inevitable and temporary outcome of the war, denoting no power on the American part to make good the ground gained. The reading may be right, but it is not in this mild and helpless mood that trade gains are wontedly regarded.

Credit Systems.—Two hundred manufacturing firms in the British woollen and worsted trade have signed a compact binding them to reform the terms of sale in two directions, and principally in respect of credit. The present time has been chosen to abolish the six-monthly terms that have been prevalent, especially in the sale of the more expensive goods. Customers have ordered in the summer goods for delivery in the autumn for payment in the spring, with the result that the producer has been out of his money for something like a whole year. They are to be required to pay in three months instead of six. Monthly settlements are substituted for seasonal settlements, and the allowances for prepayment or extension are closely defined. The scheme has created commotion amounting almost to revolution, and it is one which could not be carried through were the communal instinct not especially strong at present among manufacturers. An arrangement that makes the producer virtually the banker of the merchant and tailor is patently disadvantageous. Even the three-monthly credits remaining contrast strongly with the fortnightly settlements upon which the cotton industry has grown up.

Trade Measures.—This interference with settled practice does not stand alone. The manufacturers have found courage at last to disown the ancient practices of selling 37 inches to the yard and of allowing one-quarter yard in every ten yards. The uprooting of this custom may conceivably cost as much in disorganisation as it is worth. The cumbrousness and indivisibility are not to be denied, but men who have thought and calculated in 37-inch terms from the beginning do not readily accustom themselves to a change. The alteration of measuring apparatus in the form of tables, sticks and machines, although a fairly considerable task, is not the worst of the matter. The antiquity

of the irregular measures of the textile trade is imperfectly realised by the generality of traders. *De Ponderibus et Mensuris*, one of the earliest Norman statutes, prescribed that in every hundred ells of canvas or linen there should be six score ells. In the fifteenth century it was statutory that in the woollen cloths called Dozens there should be at least 14 yards 14 inches. Thus at this early time of day the 37-inch yard was recognised, and it was complained that London merchants were dissatisfied with that allowance, claiming in addition to the added inch, "a sauft, a powder or an hauncer." "Where they were wont to measure the Cloth by the Yard and the full inch, now they will measure by the Yard and the full Hand," says the complaint. In the upshot the yard and one inch measure was made obligatory, and a silk line, or cord, sealed at both ends and divided in 37-inch measure was placed in the hands of the aulnagers. In the sixteenth century it was enacted that clothiers should not put to sale "cloth which when it shall be full wett shall shrinke more than one yerde in all the lengthe." Either in this sanction or in one made a generation later when a concession of 1½ yards was allowed, may be descried the origin of the trade allowance known variously as the yard per piece or the quarter-in-ten. It is somewhat difficult to believe that customs so tenacious of life can be doomed actually to die on July 1st, in accordance with the edict of the two hundred manufacturers.

A Cotton Annual.—In its eleventh appearance the "Cotton Year Book" (Marsden: Manchester. 2s. 6d.) is distinctly more portly than before, reminding all concerned that the development of cotton machinery is continuous. The departures of the last twelve months have been quiet rather than bold, and in the book they are assimilated to the progress of past years. The process gives something more than a bird's-eye view of the several recognised systems of working, with summary descriptions of the machines and notes upon their working. Annual compends, relating the whole detail of processes in current use, fill a place that makes them probably the most welcome of textile publications. Their handy form and ample scope, their practical hints, definitions and oddments of information, commend them everywhere. Text-books, catalogues, monthly and weekly periodicals have their separate office, and the "Year Book" is the complement of all of them. An orderly *résumé* of cotton-trade practice running to 658 pages of solid matter serves some of the purposes of a library as well as of a book.

Luxuries and Necessities.—Silk manufacturers are not without blame for classing silk as a luxury; there are circumstances in which the description is accurate, but as much might be said of most commodities in this world. Cotton is a considerable luxury in its form of yarn at 45s. per lb., and wool is made into fabrics finer than mere necessity would ever dictate. Silk is hardly a luxury when used as a cheap substitute for wool, as waste tussah silk is now being used in America. In its ordinary employments, say in blouses or neckties, silk represents the best value for money, and this is not the characteristic of a luxury truly-called. As an article of munitions silk approaches the position of a necessity in connection with artillery. Silk is not absolutely indispensable in that field, for apparently woollen cloth is being substituted for silk as a container for cartridges. Any fabric might serve purely as a wrapper, but silk is credited with least effect in assisting erosion in the bore. Mr. Frank Warner has been at some pains to combat the loose impression that silk is all superfluity, and a close examination might show that a very small part of the goods made from silk enter into the class of luxuries. The sewing silks for Army uniforms and the woven neckerchiefs for the Navy are obviously not of that class, and for many years it has been held that far the largest proportion of British-spun silk enters into goods of a mixed nature sold at comparatively low prices. Not origins but uses determine the fact of luxuriousness. Jute is presumably a luxury when it is used to make figures on a brocade, although free from imputation when converted into a sandbag. Linen is turned into damasks as well as into aprons, and immense quantities of work are put into cottons without benefit except to appearances. In the hunt for luxuries the one important fact is to know what the raw stuff becomes, and any other line is bound to lead astray.

NOTES ON BOOKS.

COMBINATORY ANALYSIS. By Major P. A. MacMahon. Vol. I. pp. i-xx. 1-300. Cambridge: at the University Press. 1915.

In a certain sense all mathematics is a game. You make your own rules, subject only to the condition of their being mutually consistent, and your object is to produce a work of art, such as a double-dummy problem by Lewis, or an all-round break at billiards, like one by John Roberts in his prime. The theory explained in this book arose and developed from a variety of pastimes and problems connected with them—bell-ringing, games such as draughts, chess, and piquet; calculation of odds against particular throws of one or more dice, and so on. Many of Mr. Dudeney's puzzles in the *Strand Magazine* depend upon combinatory analysis, or, as Sylvester called it, "tactic." It is not easy to define its scope exactly; but we may say, in general terms, that it deals with all questions about arrangements or selections of

objects, and, for convenience, is taken to include the theory of partition of numbers, though this is more properly an application of it. We find the first outlines of the theory in Pascal, Fermat, and Euler; then for a long time it hibernated, so to speak, in two chapters of text-books on algebra—"Permutations and Combinations" and "Probability"—until it became of unexpected importance as an auxiliary in two great fields of research, namely, the theory of groups and that of the invariants of algebraic forms. Euler seems to have been the first to hit on the brilliant idea of a generating function, bottling up, so to speak, a sequence of integers into an expression which is either a rational function of one or more umbral symbols, or, at any rate, an analytical expression which is capable of equivalent transformations. For instance, the formal expansions

$$(1-x)^{-1} = 1 + x + x^2 + \ldots + x^n + \ldots$$
$$(1-x)^{-2} = 1 + 2x + 3x^2 + \ldots + n\,x^{n-1} + \ldots$$

give $(1-x)^{-1}$, $(1-x)^{-2}$ as generating functions of the sequences (0, 1, 2, . . .), (1, 2, 3, . . .) regarded as indices or coefficients respectively. Cayley, Sylvester, and Hammond largely used such equivalences in discussing complete systems of covariants and their independent syzygies.

There are two outstanding features of the present work. The first is the way in which the author contrives to make the theory one organic whole, and at the same time to discuss a great variety of problems which do not obviously fall within its scope. The chapters on chess-board arrangements and on the Latin square illustrate what we mean: so do the discussions of the *problème des rencontres* and the *problème des ménages*. The second is the author's extraordinary power of generalising, especially when dealing with generating functions. As a mathematical theory develops, the problems which it suggests become more and more complex, and the apparatus required to solve them becomes more and more elaborate. Thus in the theory of invariants, Gordan invented and perfected by years of toil his transvectant formulae, which are practically indispensable if we wish to construct a complete system for a binary form of degree higher than 6. Looking at this analytical engine, we are impressed much as we are by a spinning-jenny; we may breathe a sigh of regret for the vanished wheel, spindle, and distaff, but in this age of science we must use the new machine. Major MacMahon has invented a "master-theorem" which seems likely, in capable hands, to effect, in this theory of tactic, the same sort of metallurgic reduction as Gordan's formulae do in the other. In any case it is a very remarkable instance of formal equivalence in the field of rational algebra.

As recently pointed out by Professor Love, there is such a thing as mathematical style. In this respect Major MacMahon is impeccable, especially in the cardinal virtue of lucidity. Moreover, he sets an example which might be more often imitated than it is, and is of great help to the beginner. Besides stating and proving his general theorems, he gives particular cases in illustration, and he always illustrates his definitions when possible.

Not only by this book, but by his numerous original papers, Major MacMahon has proved himself easily first among his contemporary combinarians; so far as we know, he is only equalled (in this field) by Fermat, Pascal, Euler, E. Lucas, and Sylvester. And he is certainly the first to *methodise* the theory. All who are interested in the subject will eagerly look forward to the completion of this highly delectable and artistic work.

PRIVATE HOUSE ELECTRIC LIGHTING. By Frederic H. Taylor. Sixth Edition. London: Percival Marshall & Co. 1915.

The third edition of this convenient manual was reviewed in the *Journal* in July, 1909,* and it was then recommended to those using the electric light or contemplating its installation. Probably in the six years which have passed a good many people have transferred themselves from the latter category into the former, but the recommendation still holds good. The claim on the titlepage that the book has been rewritten may be a little excessive, but parts of it certainly have been rewritten, and the whole has been brought down to date, with considerable additions as regards alike the letterpress and the illustrations. The old arrangement has been preserved, and the non-expert reader will probably find all the information he is likely to require about installation, lamps, fittings, generators, etc.

THE BRITISH JOURNAL PHOTOGRAPHIC ALMANAC, 1916.

This bulky volume has suffered but little from war conditions, for the 1068 pages of last year have only been reduced by 87, and there should be enough left to satisfy the most ardent photographer. The almanac was started as a slim volume in 1860, and it has steadily grown in size and value ever since. It has outlived more than one competitor, and bids fair to hold the field for another half century. It includes the usual information, and is certainly the most useful book of reference a photographer can have. The principa article is by the editor, Mr. G. E. Brown, "Practical Notes on Printing Processes." About the year 1884, when describing the then newly proposed process for substituting gelatine for albumen as a medium for the sensitive salts, the present writer remarked that while great improvements had been made in the production of negatives, there still remained but one common method of printing positives, that in which albumenised paper was used, since carbon and platinum were employed only to a comparatively small extent. Mr. Brown begins his essay with a somewhat similar remark

* See *Journal*, Vol. LVII. p. 693.

that "for some years past there has been comparatively little done in the way of originating new photographic printing processes," but he might have added that those processes were numerous enough already.

In addition to this, there is the usual "Epitome of Progress," an account of the principal inventions and novelties of the past year, together with formulae, tables, etc., and all sorts of miscellaneous information likely to be useful to photographers.

A new feature in this year's almanac is an account of "British Resources in the Manufacture of Photographic Materials and Apparatus." This is a *catalogue raisonné* of the photographic manufacturers of the Empire and its allies.

As usual, a notable feature is provided by the advertisements, which form a complete photography directory. As they are placed at the beginning as well as at the end of the book, they render it needful for the titlepage to be postponed to page 335, a somewhat unusual position.

THE TROPICS. By C. R. Enock, F.R.G.S. London: Grant Richards, Ltd. 16*s*.

For some years Mr. Enock has been endeavouring to familiarise the world with a new science, which he styles "constructive human geography." He has read papers on it before the Royal Society of Arts, the British Association, and other bodies; but in case there are any who are still ignorant of the scope or meaning of this term, it may be as well to begin this notice by an attempt to define it. Mr. Enock, it seems, has been struck by the fact that while Nature is extremely prodigal of her gifts in many parts of the world, a considerable proportion of the human race live on the border-line of poverty, or below it. The object of his "constructive human geography," if we understand it aright, is by a scientific reorganisation of the industries of the earth to secure among its inhabitants a fair division of the results of their labour. The idea, it will be seen, is not wanting in boldness nor in magnitude: how far it is practicable is another question.

Before one can set about the scientific reorganisation of the industries of the earth, it is necessary to gain a clear idea of existing industries and the possibilities of further development. By far the greater part of this volume consists of a review—geographical, historical, and economic—of that huge belt of the world known as the tropics. It is not quite clear to us why the author has prescribed himself even these limits, for although "The Tropics" cover about one-third of the surface of the globe, it seems to us that the other two-thirds (or the greater part of them, at all events) have an equal right to be included in the new science. However, when the author has given us so much, it may seem ungrateful to complain that he has not given us more.

Mr. Enock has travelled widely, and those who have read his "Great Pacific Coast" and "The Andes and the Amazon" will know that he has the gift of keen observation and the power of recording what he has seen in a vivid and picturesque style. The present volume scarcely affords so much scope for his literary qualities as his earlier works, which for the most part recorded his personal experiences; it is naturally more encyclopædic in character, and is less the result of first-hand knowledge. But it contains a great amount of information, carefully put together, and is rich in suggestions as to the future development of the various countries which he describes.

GENERAL NOTES.

REPORT ON THE CONSULAR DISTRICT OF ROME FOR 1914.—The works of the new railway line from Rome to Naples are progressing, but somewhat slowly, and it is to be foreseen that the line will not be opened to traffic until late in 1916, though the most difficult part of the work from an engineering point of view seems to have been completed some time ago. An electric line is being built by an Italian company in the province of Rome, and will join the Italian capital with the famous mineral springs of Fiuggi, to be extended later on to other towns of the province, such as Alatri, Guarano, etc. The difficulty experienced during the latter part of 1914 in securing coal required by the various Italian factories, and the consequent rise of price, have been the subjects of much discussion in the Italian press. It has been suggested that in order to make local factories to some extent independent of foreign coal, the Government should encourage the exploitation of the lignite mines which are found in various parts of the country. The mines at present being worked yield about 1,300,000 tons per year, but the output could be increased to about 5,000,000 tons if the exploitation of all the mines in the country were encouraged by facilities in the way of reduced taxes, special freight rates, etc. It is estimated that the value of the coal purchased by Rome alone amounts to over £1,000,000 a year, and one-fifth of that amount could be saved if the use of lignite were resorted to on a larger scale. A recent report on the earthquake of January 13th, 1914, has been submitted to Parliament, and states that about 30,000 persons lost their lives, of whom 20,000 were in the province of Aquila alone. The Government granted certain facilities in the way of exemption from taxes, moratorium, etc., as well as a sum of £12,000,000 to be spent for the relief of the survivors and the building of temporary shelters in the affected districts. The normal commercial activities of the Roman district have been seriously affected since August, 1914,

by the war, especially on account of the absence of the customary visitors. In former years these used to flock in large numbers to the Italian capital at the beginning of the autumn, and a great many of them spent their winter there. Their absence has been seriously felt by the numerous hotel-keepers, tradesmen, etc., who are almost exclusively dependent upon their foreign *clientèle*.

PRINCESS OF WALES' SCHOLARSHIPS.—**The Board of Education announce that, as the National Competition is not this year available as a basis for award of the Princess of Wales' Scholarships, they will award one or two of the scholarships on the basis of the Examinations in Art to be held in 1916. The conditions will be, with certain modifications, identical with those for local scholarships for art.**

TREATMENT OF SNAKE-BITE.—In a paper on "Studies on the Treatment of Snake-Bite: the Present Position of Antivenene Therapy," which appeared in the October issue of the *Indian Journal of Medical Research*, Captain H. W. Acton and Captain R. Knowles, I.M.S., come to the following conclusions: With the remedies at present available for the treatment of bites from poisonous snakes, if properly applied, it should be possible to save a large percentage of the cases which now prove fatal. The general line of procedure should be as follows: (1) Apply a firm ligature immediately. (2) Impregnate the whole area of the bite with a hypodermic injection of a strong solution of gold chloride. (3) Inject from 100 to 200 c.c. of antivenene intravenously, if the biting snake be suspected to have been a cobra or Russell's viper. If symptoms of venom intoxication come on, further and even larger injections of antivenene should be given intravenously. With sera concentrated ten times, a dose of 20–60 c.c. should save every case of cobra bite.

THE EASTERN HEMLOCK OF NORTH AMERICA.—The eastern hemlock (*Tsuga canadensis*, Linn.) occurs in the white pine region of eastern North America and extends from Nova Scotia to east central Minnesota in the west, and to northern Georgia and Alabama in the south. Though excelled in most respects by other trees in the region of its growth, it is none the less a most important member of the remaining old-growth forests. Its lumber serves many purposes for which pine was formerly demanded; its wood supplies more raw material for paper pulp than does any other in the United States except spruce, while the amount of its bark used in the United States for tanning exceeds that of all other native species combined. It is, however, a slow-growing tree, and it will not pay to encourage its reproduction on fertile soil where a good deal of the remaining old-growth hemlock timber at present exists, if it is suitable either for agriculture or for raising timber crops of rapidly growing species. In *Bulletin* No. 152, 1915, *U.S. Dept. Agric.*, a full account of the characteristics and distribution of the tree is given, together with information as to the amount and value of the standing timber in the United States, its utilisation for lumber, pulp, tanning bark and other purposes, forest management, etc.—*Bulletin of the Imperial Institute.*

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

MARCH 29.—R. W. SETON-WATSON, D.Litt., "Pan-German Aspirations in the Near East." SIR EDWIN PEARS will preside.

APRIL 5.—ARTHUR S. JENNINGS, "Painting by Dipping, Spraying, and other Mechanical Means."

MAY 3.—PROFESSOR W. B. BOTTOMLEY, M.A., F.C.S., F.L.S., "Bacterised Peat."

MAY 10.—SIR FRANCIS TAYLOR PIGGOTT, M.A., LL.M., Chief Justice of Hong-Kong, 1905–1912, "Contraband and Blockade." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

APRIL 27.—JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

MAY 18.—SARDAR DALJIT SINGH, C.S.I., "The Sikhs."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

MARCH 28.—PERCY HURD, "Next Steps in Empire Partnership." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

APRIL 11.—SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Timber Resources of Newfoundland." The Right Hon. SIR WILLIAM MACGREGOR, P.C., G.C.M.G., C.B., will preside.

Dates to be hereafter announced:—

JOHN COLLETT MOULDEN, A.R.S.M., M.Inst.M.M., "Zinc, its Production and Industrial Applications." (Peter Le Neve Foster Prize Essay.)

G. P. BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries,

and their Influence on the Tinctorial Arts of Europe."

PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India." The Right Hon. LORD ISLINGTON, G.C.M.G., will preside.

FOTHERGILL LECTURES.

Monday afternoons, at 4.30 p.m.:—

EDWARD A. REEVES, F.R.A.S., F.R.G.S., Map Curator and Instructor in Surveying to the Royal Geographical Society, "Surveying, Past and Present." Three Lectures.

Syllabus.

LECTURE I.—MARCH 27.—*Historical Sketch.* Introductory remarks—First attempts at surveying—Early surveying instruments and methods—First attempts at measuring size of earth—How early charts and maps were made—Beginnings of astronomical observations for fixing positions—Improvements in instruments and methods introduced in fifteenth century—First triangulation—Survey basis of early British maps—Further improvements in instruments and methods.

LECTURE II.—APRIL 3.—*Present position of Surveying and Mapping of the World.* General account, illustrated by maps and diagrams showing (1) parts of the world topographically mapped from reliable surveys, (2) those less accurately mapped from surveys chiefly non-topographical, (3) parts only roughly mapped from route traverses, and (4) those still entirely unsurveyed—Facsimiles of MS. maps of well-known explorers—Specimens of different kinds of surveys from which the earth has been mapped, with general account of them—Part taken by the Royal Geographical Society in promoting exploration and surveying—Work of the future.

LECTURE III.—APRIL 10.—*Modern Instruments and Methods of Geographical Surveying.* Advance made in recent years—Difficulties of obtaining accurate measurements—Circumstances that determine character of survey—Theodolites—Base line apparatus—Triangulation, with recent examples—Traverses with theodolite and tacheometer or subtense instruments — Plane-table, its use in topographical mapping, and recent improvements—Determination of heights—Photographic surveying—Astronomical observations for fixing positions.

The lectures will be illustrated with lantern-slides.

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m.:—

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

May 1, 8, 15, 22.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 27...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Fothergill Lecture.) Mr. E. A. Reeves, "Surveying: Past and Present." (Lecture I.)

Farmers' Club, Whitehall-court, S.W., 4 p.m. Mr. H. T. Eve, "County War Agricultural Committees."

TUESDAY, MARCH 28...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Mr. P. Hurd, "Next Steps in Empire Partnership."

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. Keeble, "Modern Horticulture. Lecture I.—Plants and the Seasons."

Anthropological Institute, 50, Great Russell-street, W.C. Joint meeting with the Prehistoric Society of East Anglia. 2 p.m. 1. Dr. A. E. Peake, "Grimes Graves and Allied Cultures." 2. Mr. A. S. Kennard, "The Pleistocene Succession in England."

5 p.m. Miss N. Layard, "Hand Grips." 2. Rev. F. W. Hayes, "Irish MS. and other Evidence of the Use of Stone Weapons, including Smooth Stone Celts within Historic Times."

Colonial Institute, Hotel Cecil, Strand, W.C., 4 p.m. Mr. E. S. Bruce, "The Aëroplane and its Use in War."

WEDNESDAY, MARCH 29...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Dr. R. W. Seton-Watson, "Pan-German Aspirations in the Near East."

Sanitary Institute, 90, Buckingham Palace-road, S.W., 4.15 p.m. Mr. G. M. Pettit, "Made-Down and Tenemented Houses."

Metals, Institute of, at the Chemical Society, Burlington House, W., 4 p.m. Annual Meeting. Address by the President.

8 p.m. 1. Third Report to the Corrosion Committee. 2. Mr. E. Cumberland, "The Electrolytic Method of preventing Corrosion." 3. Professors A. A. Read and R. H. Greaves, "Note on some Tin Aluminium-Copper Alloys." 4. Mr. W. B. Withey, "Notes on the Analysis of Aluminium and its Alloys." 5. Mr. F. C. Thompson, "The Annealing of Nickel Silver." 6. Professor A. Stansfield, "Electric Furnaces as applied to Non-ferrous Metallurgy." 7. Drs. N. S. Kurnakow, S. Zemczuzny and M. Zasedatelev, "Transformations in Alloys of Gold and Copper."

THURSDAY, MARCH 30...Royal Society, Burlington House, W., 4.30 p.m.

Child Study Society, 90, Buckingham Palace-road, S.W., 6 p.m. Mr. C. M. Chapman, "The Child Delinquent."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. Hadow, "English Music in the Tudor Period. Lecture I.—Church Music."

Camera Club, 17, John-street, Adelphi, W.C., 8 p.m. Mr. M. Adams, "Both Sides of Child Life, expressed by my Camera."

FRIDAY, MARCH 31...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor A. Fowler, "The Spectra of Hydrogen and Helium."

Sanitary Institute, Physics Theatre, University, Liverpool, 3.30 p.m. Professor J. M. Beattie, "Tubercular Disease of Children and Milk Supply."

SATURDAY, APRIL 1...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Radiations from Atoms and Electrons." (Lecture IV.)

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Journal of the Royal Society of Arts.

No. 3,306. VOL. LXIV.

FRIDAY, MARCH 31, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

NEXT WEEK.

MONDAY, APRIL 3rd, 4.30 p.m. (Fothergill Lecture.) E. A. REEVES, F.R.A.S., F.R.G.S., Map Curator and Instructor in Surveying to the Royal Geographical Society, "Surveying: Past and Present." (Lecture II.)

WEDNESDAY, APRIL 5th, 4.30 p.m. (Ordinary Meeting.) ARTHUR SEYMOUR JENNINGS, F.I.B.D., "Painting by Dipping, Spraying, and other Mechanical Means."

PROCEEDINGS OF THE SOCIETY.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 29th, 1916; SIR EDWIN PEARS in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Adenwala, Moteeram Heerabhoy, Heera Bag, Shahibag Post, Ahmedabad, India.

Kale, Professor Vaman Govind, M.A., Fergusson College, Poona, India.

Khan, M. A. Lateef, Furhut Munzil, Saifabad, Hyderabad, Deccan, India.

The following candidates were balloted for and duly elected Fellows of the Society:—

Kewley, James, M.A., Cambrian Lodge, Portishead.

Walker, Basil Woodd, M.D., 6, Dawson-place, Pembridge-square, W.

The paper read was—

PAN-GERMAN ASPIRATIONS IN THE NEAR EAST.

By R. W. SETON-WATSON, D.Litt.

It has become a commonplace of writers on the war to say that Germany is a danger to Europe. In a sense this is of course true, but it gives a wrong focus to the truth. For no nation, so long as it is content with its national unity and independence and the development of its own resources and culture, can fairly be described as a menace to its neighbours. That stage is only reached when it begins to regard its own civilisation as a species of superculture, and its leaders as supermen who have the mission of imposing their wishes and ideas upon the outside world. It is not, then, Germany, *as Germany*, that threatens Europe's whole future. There have been cases before in history, when a great nation went mad for a time and yet recovered from its madness. The classic example is that of our nearest and dearest Allies, the French, during the orgies of the Reign of Terror. And it may be that in the same way Germany will recover from the madness which has devastated Belgium, Poland, and Serbia, and that some intercourse between her and her neighbours to the West and East will again be possible. At a moment when her submarines and Zeppelins are murdering at random, and her soldiers are drugged with ether for the assault, this may appear little better than a pious hope.

But to-day the essential fact with which we have to reckon is that Germany is more united than ever before, and that the classes which control her destinies—not merely the narrow military clique at the top, but the whole vast organism of the bureaucracy, army, and professional and academic classes—are inspired by a programme which may be summed up in three words—*Deutschland ueber Alles*. Fortunately this has at last become too obvious to be ignored, and is, indeed, only contested by a few cranks, who have been far too often wrong in their estimates and prophecies to obtain credence now. Strangely enough, however, the real urgent menace from Germany has been, to a large extent, overlooked by our public opinion or merely alluded to in passing. This menace lies in the fact that Germany controls the destinies

of the 51,000,000 who inhabit the Austro-Hungarian Monarchy—to say nothing of the 20,000,000 of Turkey and the 4,000,000 of Bulgaria—and is ruthlessly exploiting them in a cause which the vast majority of them regard with complete indifference, and at least half of them with utter loathing. Just as the harmless Anatolian peasant is fighting the battles of Enver Pasha—the murderer of his commander-in-chief, his Grand Vizier, and now the heir-apparent—so the thirty-five million Slavs and Latins of the Central Empires are being used as "food for cannon" in a death struggle against their own kinsmen and their dearest national ideals. Thus the main task before us, if we are really to reconstruct Europe on new and healthy lines, must be to detach these peoples from their present thraldom to Berlin, Vienna, and Budapest, to liberate the Slav democracies of Central Europe, and to secure to them the means of progress and organisation upon a national and independent basis. This task has the further military advantage that it enables us to attack Germany at her weakest, and no longer at her strongest, spot; for the events of the war have only served to prove that some of the leading French strategists were right in maintaining that the true field for a successful offensive lies through the great Hungarian plains, not through the brick walls of Belgium. By our planlessness and levity we have abandoned the magnificent natural frontier from the Adriatic to the Danube, which was at our disposal for the first fourteen months of the war, and we did not even take the trouble to defend Mount Lovčen, the key of the Adriatic, from the assaults of Austria. But though our folly has made the task infinitely more difficult, it still lies before us. If to the conquering Germans last autumn Serbia was the route to the East, she is also the route to the West for the Allied armies.

Before the war in Germany, as in all other European countries, our own included, there were two currents of opinion, the one definitely opposed to adventure or expansion, the other as definitely basing itself upon force as the root of all progress. No one who visited Germany frequently, or was in the habit of reading German political literature, could fail to be aware of the existence of an active Pan-German movement, and of a propaganda which often assumed an anti-British complexion. Our mistake lay in over-estimating the strength of those saner forces in German public opinion which made for peace. At the end of July, 1914, those forces proved themselves to be utterly impotent, and were swept away by the march of events. The inevitable result has been to bring the Pan-German programme within the range of practical politics and to increase immensely its appeal and its popularity. It may be argued that we were always wrong to ignore its significance; to-day our most vital interests demand that we should study it in all its bearings.

There are three stages in the Pan-German plan: (1) The creation of "Mitteleuropa," a great Central European state-organism of 130 to 150 million inhabitants, as an economic and military unit; (2) the realisation of the dream Berlin-Baghdad, by the inclusion in the political and economic spheres of influence of the new Zollverein of all the territory lying between the Hungarian frontier and the Persian Gulf; and (3) naval supremacy and Weltmacht. The vital problem of this war, upon which the whole future development of civilisation depends, is whether we are to oppose this programme or to submit to it as inevitable. At such a moment there can be no half measures; the answer must be yes or no. If no, this war is an act of criminal folly which has no parallel in history. If yes, we must not wait till the enemy's plan has reached maturity, but must overthrow it in its initial stages. It was a German poet who told us that what we have inherited from our ancestors we must earn again in order to possess (*Was du ererbt von deinen Vätern hast, erwirb es, um es zu besitzen*). That is a lesson which we have been in danger of forgetting, and which Germany is teaching us. For the future we must throw off the insularity which left us ignorant or oblivious of hostile designs, nor must we ever allow a situation to arise in which we might seem indifferent to events upon land simply because they take place at the other end of Europe. For such indifference is the surest way to alienate our Allies, who realise to the full the close interconnection of West and East and South-East, and expect us to realise it equally. If we are right in regarding sea power as the key to victory, it is none the less true that the extension of German land power will be the prelude to a fresh attempt to challenge our security on the sea. That is, of course, the true inward explanation of the presence of British armies upon French soil; but while everyone to-day realises the need of countering the German land plan on the West, the equally urgent and overwhelming need of countering the Germans in the East of Europe has still not been sufficiently realised. There are still quite serious and well-

meaning people who argue that if the Germans could be once ejected from Belgium and Northern France, our aims in the war would be achieved. To them all the vast problems of Central and Eastern Europe are a mere blank. In seeking to differentiate between Germany and her Allies, they fail to realise the fact that it is no mere accident that has brought Prussia, Hungary, Turkey, and Bulgaria into line. All four stand for the same principle of racial hegemony. The only difference lies in the varying degree of crudeness with which that policy is pursued in Posen, in Transylvania, in the Balkans, and in Armenia.

If the German plan of "Berlin-Baghdad" is to be countered, we must find obstacles to place in its path, and in so doing we can only build with the material which is already to our hand. This consists, above all, of the Slav and Latin peoples of Austria-Hungary and South-Eastern Europe generally, who are eager to lead their own national lives, and the fulfilment of whose aspirations coincides absolutely with British interests and the interests of the Entente as a whole. Till the very eve of war, and even later, it was the fashion in certain circles to regret our political ties with Russia on the ground that the Slavs are barbarous. It would be as easy as it is superfluous to prove that the Russians, the greatest of all the Slav nations, are anything but barbarous, and that they have much to teach us all—above all, the Kulturvolk *par excellence*—in every branch of science, art, literature, and music. But my present object is to emphasize that it is an equally gross libel, and in some directions an even grosser libel, upon the other Slav nations also. The next two in importance, the Poles and the Czechs, far from being barbarous, have ancient cultures and literatures of their own, and have played a notable part in European thought and progress. The Slovaks are perhaps the most attractive and naturally gifted of all the Slav nations, and only await the removal of the tyrannous Magyar yoke in order to reveal their latent talents to the world at large. The Serbs and their Croat and Slovene kinsmen, the three branches of the Jugoslav race, are also noticeable, not only for their heroic endurance against fearful odds, but above all for the virile perseverance which has created, without external aid, the most democratic of peasant states in modern times.

One further point deserves special emphasis in this connection, namely, the essential error which underlay our diplomacy in the years preceding the war, in the treating the Balkans and Austria-Hungary as two watertight compartments. It lies quite outside my present purpose to describe the process by which the Germany of the Burschenschaften and Turnvereine, of the Romantic Era in literature, and of liberalism in the Swabian and South German form, was transformed by the genius of Bismarck and his group into the Prussianised Germany against which we are pitted to-day, and which rests upon the material doctrines of blood and iron, and of brute force as the sure forerunner of national prosperity. During the generation which separated the Congress of Vienna from the Revolution of 1848, the aspirations of the leaders of German thought were directed, at one and the same time, towards national unity and constitutional liberty and reform. But the reform movement was shipwrecked at Frankfurt in 1848. Unity was only possible on a unitary basis. Two masters were impossible; either Prussia or Austria had to give way. The idealists of Frankfurt dreamed of a "Great Germany," the Germany of 70,000,000, as they reckoned even then. But the inclusion of Austria with her non-German elements would have created a dangerous dualism and prolonged still further the rivalry of Habsburg and Hohenzollern. Bismarck achieved German unity on rather narrower lines by the elimination of Austria. He achieved it in seven years by three successive wars of aggression, in which appearances were carefully preserved till long after the event. But for his remaining twenty years of office, with the notorious exception of 1875, when he was within an ace of attacking France once more, he favoured peaceful development, and posed as the peacemaker and honest broker. Nor was this a mere pose, and there are no grounds for doubting his sincerity when he applied the famous phrase "satiated" (*saturiert*) to the territorial appetites of Germany; and when he declared that the whole Eastern Question was not worth the bones of a single Pomeranian grenadier. The modern German tendency to repudiate his attitude in this respect has obscured the extremely subtle nature of his policy. The same attitude which, in the Austro-Prussian War of 1866, made him lie in despair upon his bed and tear the bedclothes with his teeth when William I. wanted to annex Bohemia, was reflected in the memorandum which he addressed to William I. in 1871, to the effect that it was far more advantageous for Germany to extend her influence over the Slavs through the medium of Austria than to annex the German

subjects of the House of Habsburg. A whole volume could easily be devoted to a discussion of his motives in 1866, in suggesting that Budapest was a better centre than Vienna for the reconstruction of the Dual Monarchy. But it is quite clear that he aimed at the political organisation of Austria-Hungary as an instrument of German policy; and with that aim always in view the Czechs were isolated, the Poles discreetly held in check, and the Magyars flattered and encouraged. So firmly persuaded was Bismarck of Austria's value to Germany, that when the Eastern Question separated Austria from Russia and forced Bismarck to a decision, he chose Austria without hesitation. Thus arose the Dual Alliance, which in 1882 became the Triple Alliance. Throughout these years Bismarck favoured the league of the three Emperors, and sometimes managed to attain it, though never permanently; and his leanings towards Russia, or the Tsarist system, led him to conclude the famous Reinsurance Treaty (*Rückversicherungsvertrag*). But determined as he was to remain on friendly terms with Russia, he was never prepared to pay the price of deserting Austria.

Bismarck's aim then was slow infiltration. He once said to Hermann Bahr, the novelist, who as a young man headed a deputation of Austrian students: "That he was glad to see that the German Austrians were such good Germans; but that they could not prove this better than by making Austria strong. Germany needed them and reckoned upon them, but *inside Austria*." To-day we are beginning to see the meaning of this policy. On a similar occasion, in 1895, Bismarck said: "To prove effectually your sentiments towards the German Emperor, fulfil all your duties towards your own dynasty. I advise you to show condescension and indulgence to your Slav neighbours." In the same way he steadily discouraged political demonstrations directed against Austria, and in 1897 induced the Reichstag to reject a motion of sympathy with the German nationalists of Austria. In short, he desired a perpetual political alliance between Germany and Austria, if possible, leading to a Zollverein, but very possibly nothing more.

It is sometimes argued that because Germany's present-day ambitions follow quite naturally out of Bismarck's policy, therefore Bismarck was a Pan-German. That is as true and as false as to describe Drake or Nelson as an Imperialist; for every man lives in his own age. It may be that his biographer, Erich Marcks, is right in claiming that Bismarck would be heart and soul with his people in their struggle to-day. But it is difficult to avoid the suspicion that Marcks and many of his compatriots feel, in their heart of hearts, that Bismarck would never have involved Germany in such a war. For to-day Germany is fighting at one and the same time the three wars which her Jingoes would have liked her to fight in succession—the war against Russia and Slavdom, for the domination of Middle Europe and the Near East; the war against France, to silence the promptings of *revanche* and to win the mouths of the Scheldt and the Rhine; and the war against Britain, for sea power and world dominion. Bismarck would certainly have taken them singly. There is another direction, however, in which it is possible to trace the hand of Bismarck on the tragedy of to-day, in his policy of the "strong hand" against the Poles of Posen and Silesia. Despite his platonic advice to Austrian students, he pursued an anti-Slav policy in the most acute and irreconcilable form, and contrived to combine it with a firm league with the Russian Court. Thus under Bismarck we find the curious paradox of Petrograd, inspired by German influence, following an anti-Slav policy in Poland, and thus weakening Russian prestige in the Slavonic world. The Polish partition is the great initial crime which lies at the root of all European troubles for a hundred and fifty years past, and which has committed the three spoilers to the support of an evil situation. Now that Russia has broken with Germany, and is very slowly but noticeably preparing to atone for the crimes of the past, we have the right to expect a complete transformation of Russo-Polish relations, and consequently of the whole situation between the Baltic and the Danube.

The eighties were a period of mild colonial expansion on the part of Germany, but it was not until the accession of William II. that the new era can be said to have begun. Pan-Germanism raised its head and kept pace with the tremendous outburst of economic activity and material prosperity. *Weltpolitik* (world policy) became the new cry, and William himself became its mouthpiece. In 1896, the year of the Kruger telegram, he made one of his most memorable speeches: "Out of the German Empire a world-empire has arisen. Everywhere in all parts of the earth thousands of our countrymen reside. German riches, German knowledge, German activity find their way across the ocean. The duty devolves on you to help me to knit

this Greater German Empire close to the home country, by helping me in complete unity to fulfil my duty also to the Germans in foreign parts." Thus was inaugurated the new Imperialism. The motto of the Great Elector—"Remember that you are a German" (*Gedenke dass du ein Deutscher bist*)—became the motto of Emperor and people. What more natural and estimable than this encouragement of national sentiment? How could we, who were at that very moment engaged in knitting our own Empire more closely together, venture to criticise the Emperor's attitude? What more unexceptionable than William II.'s words, if they had been pronounced by a man of normal temper and not accompanied by a whole series of reactionary and arrogant utterances? It is unnecessary to go through the long catalogue. "*Sic volo, sic jubeo.*" "Him who opposes me I will crush." "Our future lies on the water." "The trident must be in our hands." "The Emperor of the Atlantic to the Emperor of the Pacific." "Peoples of Europe, guard your holiest possessions." "No quarter will be given, no prisoners will be taken . . . Open up once for all a way for Kultur." The last two sentences, incredible as it may sound even to-day, belong to one and the same speech. In William II.'s unbalanced imagination a glorious ideal becomes raucous and rings false. The pure enthusiasm of the patriot soldier-poet, Theodor von Körner, who apostrophised the sword upon his thigh on the evening before he gave his life in the War of Liberation of 1813, becomes the nauseous military sentiment which makes the German Crown Prince proclaim his regret that a cavalry charge at manœuvres is not the "real thing."

The old idea that Germany is "satiated" comes to be more and more keenly repudiated, not only by the Pan-German extremists, but by all the sanest and most influential political writers. We hear more and more of *Kulturdünger* ("the manure of culture"); of the crude gospel of materialism; of the doctrine of the superman and the "strong hand"; of the supreme morality of war; of military strategy as the basis of all political organism and of all international frontiers; of the theory that small states cannot subsist and must inevitably become the prey of the great. That least aggressive and greatest of all German writers, Goethe, once declared that every man had the choice between becoming hammer or anvil. The Pan-Germans caught up this phrase, and preached the view that after being the anvil for centuries the German must insist upon becoming the hammer. The essence of these modern doctrines may be summed up in the teaching of Treitschke—"the State is Power."

One of the main secrets of German success has been those habits of association and co-operation to which their mediæval cities owed much of their prosperity. Just as the student societies played a predominant part in the War of Liberation, so the eighties and nineties which led to the war of Hegemony were a period of the foundation of every kind of patriotic and political society. In 1880 the Deutsche Schulverein was founded in Vienna for the support of German schools, and in the following year its namesake in Berlin was established. The aims of these societies, which are still very active, though perhaps slightly less powerful since the year 1895, were by no means confined to preserving the German position in such mixed districts as Bohemia, Silesia, Posen, Hungary, and Styria, but also to propagating in the intensest manner possible the German idea all along the non-German borderland. An older society, the Gustav-Adolf-Verein, has devoted itself to the support of German Protestant congregations in difficulties, and has done splendid work against Magyar aggression; but, despite its genuinely Protestant zeal, it must be regarded as an eminently political organ. The three colonial societies—the German Colonial League, the German Colonial Society, and the Society for German Colonisation—have all exercised a very marked influence upon public opinion in Germany. The so-called *Schützvereine* (Leagues of Defence), which sprang up in every direction throughout the Polish districts of Germany, the German and mixed districts of Bohemia, and the countries lying between Vienna and the Adriatic, have at one and the same time strengthened the German element wherever it was forced upon the defensive, and intensified the racial struggle by every kind of offensive tactics. Above all, the notorious Deutsche Ostmarkenverein (1894), which has acquired the nickname of the "Hakatist" League from the first letter of the names of its three founders Hansemann, Kennemann, and Tiedemann, led a fierce and merciless attack upon everything Polish—schools, traditions, culture, religion—and became the foremost champion of the brutal policy of land expropriation pursued by the Prussian Government.

There is, however, one society which has attained special notoriety and which deserves fuller treatment, because though often pooh-

poohed even by quite serious Germans before the war, and though always ahead of German public opinion, and indeed extravagant and fantastic in its aims and utterances, it has, in this present war, come into its own, and proved, not only to Germany but to all Europe, that its vapourings and frenzy are not merely Utopian, but *Realpolitik* of the grimmest kind. This is the Pan-German League, which, first founded in 1886 by the notorious Dr. Carl Peters as the Allgemeine Deutsche Verband, to encourage colonial expansion, was transformed in 1895 by Dr. Hasse, the deputy for Leipzig, into the Alldeutsche Verband. Its programme was one of expansion and dominion, of the community of all branches of the German race (*Gemeinschaft aller deutscher Stämme*). It favoured the restoration of the ancient frontiers of the mediæval Empire, the redemption of all German outposts at the expense of the enemy at the gates, the consolidation of Central Europe on a Teutonic and at the same time on an economic basis. It worked through perpetual meetings and agitation, and the noisy cries of its platform orators were reflected in its official organ, the *Alldeutsche Blätter*. It would be very easy even to-day to exaggerate its influence in the years preceding the war. But it certainly acted as a permanent stimulant to the Government, especially in matters of emigration and colonial expansion. Above all, it stirred up public opinion and accustomed it to think of world-problems which had hitherto lain outside the German ken. It would not be accurate to assert that William II. encouraged the League, but he has always worked upon parallel lines. Another famous speech, delivered in 1898, in which he urged "the unity and co-operation of all the German tribes," aroused special enthusiasm in Pan-German circles owing to its use of the central phrase in the League's programme. The agitation of the Pan-German League unquestionably paved the way for the first Navy Bill and popularised the German fleet, especially in Bavaria and the south. Its programme may be summed up under three main heads. No German must be de-Germanised, or lost to his nationality; the fleet must form the link with all Germans overseas; and an active Pan-German propaganda must prepare the colonisation of Central Europe.

Before the war there was a widespread tendency in this country to speak of the Germans as incapable of colonisation. This cheap contempt for a rival who has since become an active enemy is a very dangerous theory. It may be true enough of the particular territory acquired in Africa by the Prussianised Empire of the Hohenzollern; but it is most emphatically not true as an historical statement. Indeed, the growth of such a theory is due to our neglect of European history, and of the racial facts which underlie and explain that history. The very name of Prussia is Slavonic. Berlin is built on territory once occupied by Wends, Obotrites, and other vanished Slav tribes. Pomerania, which derives its name from the Slav Pomorska (Shoreland), was only Germanised in the seventeenth century. The twin dynasties of Mecklenburg are purely Slav in origin. The Mark of Brandenburg is sprinkled with Slav names. East Prussia was Germanised by fire and sword by the Teutonic Knights and the Knights of the Sword, and as a result the Baltic provinces of Russia fell under the dominion of a German landed aristocracy, which retained its influence upon the Russian Court till the very eve of war. The great seaport of Riga has been a centre of German influence, and Dorpat University was purely German till less than a generation ago. The name of Austria—Oesterreich—signifies the East Mark, the outpost of Germanism in its early struggles against Celt and Slav; and much of the present German territory of Austria has only acquired its present racial character as the result of centuries of strife. Since the beginning of history Bohemia has been the battle-ground of Slav and Teuton, and a notable field of German colonisation. In the north of Hungary there is scarcely a town which was not founded by German settlers and does not preserve to this day much of its German character. In Transylvania the virile little Saxon colonies have preserved their national identity since the twelfth and thirteenth centuries. In the kingdom of Hungary as a whole there are to-day over two million Germans. There are German colonists even in Rumania, in the delta of the Danube and in the northern valleys of Bosnia; while in South Russia and the Caucasus they are numbered by the hundred thousand. Thus the *Drang nach Osten*, so far from being a new event in history, dates back eight centuries and more. It is a commonplace to say that nationality in its modern sense is a very recent development; but that does not mean that national consciousness was non-existent in earlier centuries. Even in this island, Scotland and Wales are a proof to the contrary. For a thousand years past a fierce racial struggle has raged between Germans and Slovenes in the Styrian Alps and

the Karst, between Germans and Czechs in Bohemia and Moravia; and since 1850 this struggle has been intensified tenfold. The present war is perhaps its supreme expression; for it is essentially a national war, upon whose issue will depend the future development of the Slav and Teutonic races.

We must not, then, despise the Germans as colonists. They may not be suited for Africa or Australia; but for Europe they most emphatically are. And if they are formidable to-day, it is, as we have seen, above all because they control the destinies of so many millions of alien race who are liable alike to military and economic exploitation, and may at any moment become the victims of a policy of assimilation and colonisation. The only sure way to curb them, and to reduce them within reasonable limits, is to free from their control those other races which, though weaker, have an absolute right to as free an existence and development as the Germans themselves.

Wars and revolutions are thought out in conspirators' garrets and in professors' studies and class-rooms. Mazzini made United Italy possible. Adam Smith laid the foundations of the British mercantile system. Despite our many Empire builders, it was Dilke and Seeley who first taught us to think Imperially. In the same way, Treitschke and Sybel, List and Mommsen, kindled the modern Prussian tradition. Nowhere has the professor, and above all the historian, played the part of the prophet more effectually than in Germany. In the words of one of the ablest German political thinkers, Friedrich Naumann, "When I speak of the historian as the trainer for politics, I see on his right hand the philosopher and on his left the poet."

The German national movement of a century ago is one from which no impartial student of history can refuse his sympathy and admiration; and the figures of Stein as statesman, Fichte as philosopher, Arndt and Körner as poets, Jahn as organiser of patriotism, cannot be held responsible for their brutal and degenerate descendants. Unhappily, the dream of German unity was not to be realised by the admirable methods of South German liberalism, but by the blood and iron of the Prussian Junker. Our natural detestation for the one need not blind us to the merits of the other, as originally conceived; but it is also necessary to point out that even among the idealists who gave to the War of Liberation its inspiration and its programme, the first traces of the modern Pan-German doctrine may be detected. Arndt regarded the fate of small nations as sealed; his whole outlook was vitiated by the theory that the Rhine from source to mouth is the heritage of Germany—a theory which, of course, involves the disappearance of Holland and Switzerland. "The German," he argued, "warlike, enterprising and resolute, has been created to co-operate in the domination of the world"; and his natural mission is one of colonisation. "Turnvater" Jahn, whose influence upon the youth of Germany in the first half of the nineteenth century was incalculable, dreamt of banishing Austria and the Habsburgs to Belgrade and Semlin, and argued that the Pan-German capital must be erected "halfway between Geneva and Memel, between Trieste and Copenhagen, between Dunkirk and Sandomir." It was on this generous basis that he dreamt of erecting German unity.

Parallel with the epochmaking work of Clausewitz, who placed the teachings of strategy upon a modern scientific basis, we find the less profound, but still highly significant writings, of Dietrich von Bülow, who evolved an elaborate theory of political strategy as the true basis of all modern statecraft. His influence can be traced down to the present day, especially in two of his favourite contentions—that only offensive wars can hope to succeed, and that small states are doomed to inevitable extinction.

One of the foremost links in the chain of Pan-Germanic doctrine was the famous economist Friedrich List, who inspired that policy of economic union—or "Free trade within the Empire," to use a more modern phrase—which was a necessary preliminary to German unity in 1871. It was List who said, over two generations ago: "He who has no share on the seas is shut out from the good things and honours of this world. He is a stepson of God." He, like Treitschke after him, declared that Holland can only hope to regain even part of her former prosperity by union with Germany. To him the "Continental System" of Napoleon ceased to be a monstrous idea, if Germany, not France, could be made the centre of economic union. The Continent must be organised as a unit against Britain on the one hand and Russia on the other. It was List also who preached and foretold an union of hearts between Germans and Magyars, and Turkey's destiny as the heritage of Germany.

Another of the founders of modern Germany, Hellmuth von Moltke, as a young man travelled

in the East, and resented the complete absence of German influence. In his writings he favoured the foundation of a German principality in Palestine, and expressed the hope "that Austria will maintain the rights and safeguard the future of the Danubian countries, and that Germany will finally succeed in liberating the mouths of her great rivers," *i.e.*, the Rhine and the Danube. Here we already see the germ of "Berlin to Baghdad" in the earlier form "Rotterdam to Constantinople."

The literature of Pan-Germanism deserves closer attention than it has hitherto received in this country. I do not refer to such wild lucubrations as "Germania Triumphans," "The Reckoning with England," "The Coming War"; for mountains of such trash have appeared during the last twenty years both in Germany and in England, and though not without a certain psychological effect upon the masses, need not be taken very seriously. Nor is it necessary to dwell upon the writings of General Bernhardi, Colonel Frobenius, and others who acquired a sudden notoriety on the declaration of war. Far more important, and yet almost unknown in England, is the figure of Paul Lagarde, who even before the war had come to be more and more recognised as the true spiritual father of Pan-Germanism. In private life, Lagarde was Professor of Oriental Languages at Gottingen, and a scholar of high distinction, whose work marked an epoch in the study of the Septuagint and Greek patristic literature.

But Lagarde's true significance lies in the collection of "German Writings" (*Deutsche Schriften*), in which he concentrated his political creed. Compounded of a fervent Protestantism of the period which preceded David Friedrich Strauss, an uncompromising anti-Semitism, based upon an inversion of the New Testament, and an ultra-Conservative outlook upon social problems, he stated his main political thesis as follows in a letter of dedication to Prince William (now William II.) in 1886: "Little Germany is only to be regarded as a perhaps inevitable and necessary stage on the march towards Great Germany, just as the North German Confederation was a stage towards the present German Empire." In his view, the proper work for the German race was colonisation: and the non-German districts of Austria-Hungary and Germany must be Germanised, if not even Prussianised. He accepted Italian unity, and looked upon Croatia and Serbia as capable of forming an independent state, "because inhabited by a homogeneous and cultivated population and contiguous with kindred tribes." But the Turks, Magyars, and the whole Ural-Altaic stock are, he argues, played out; while "Magyars, Czechs, and other such nationalities under the sceptre of Austria are a burden upon history, but can serve as the mortar for a nobler race." German colonisation, then, must be conducted on a careful strategic plan, extending throughout the Polish, Slovak, Czech, and Magyar territory. Germany must find new and strategically tenable frontiers, annexing on the west Alsace-Lorraine as far as the Argonne, and on the east Russian Poland as far as the Pinsk marshes. Under no circumstances must Germany's frontiers towards Austria ever become those of a hostile state. Central Europe ("Mitteleuropa"), then, must be regulated anew, as a pledge of peace: an indissoluble offensive and defensive alliance must be followed by the Germanisation of Austria. "They all"—Magyars, Czechs, Jews, etc.—"hate us, because they know that our life is their death, and that without us they cannot exist spiritually, and in spite of this will not recognise our superiority." In 1875 Lagarde was already urgently advocating a scheme of German colonisation in Posen and West Prussia, "when not a soul in authority thought of the need for making a stand against the Slavs in the East"; while in 1885 he further favoured the creation of "profitable posts" for German princes in the Balkans, similar to those already existing in Rumania and Bulgaria. "Even a King of Armenia," he argued, "would, in following an Armenian policy, be just as surely following a German policy as Alexander of Bulgaria and Charles of Rumania."

Lagarde and Treitschke were the forerunners. But during the reign of William II. there has been a flood of Pan-Germanic literature, much of it fantastic and negligible, but some of it strangely prophetic in the light of recent events. A few of its most characteristic products deserve special attention.

In 1895 an anonymous Pan-German writer published, under the title of "Great Germany and Central Europe in the Year 1950," a book which enjoyed considerable vogue by reason of its audacious and detailed programme. According to it, Germany was to be transformed into the "Great-German League" by absorbing the Austrian Empire, Holland, and Belgium, the Walloon districts of which would fall as a sop to the French Cerberus. Thus Rotterdam and Antwerp on the north, Trieste on the south, would become German ports, the possession of

the latter being, in the opinion of this writer, as in that of Lagarde, a matter of life and death. But this league is to be but the foremost member of a "Great German Customs Union," of which the other five members are to be a Baltic Principality; the Kingdom of Poland; Greater Rumania, conceived as a buffer state between Russia and the Balkan Slavs; a Kingdom of the Ukraine, including Odessa; and Greater Serbia. The German Navy would thus be supreme on the Adriatic and the Black Sea. To-day who would dare to dismiss the programme as a mere Utopia?

An abler and extremely popular exposition of a similar theme is the pamphlet of Karl von Winterstetten — "Berlin-Baghdad: New Aims of Mid-European Policy"—whose programme is summed up as follows: "New peasant land, a great economic area, the salvation of Germanism in the Danubian Monarchy, the union of all Germans, a free path to the South-East, protection of the non-Slav races of the South-East against Pan-Slavism—in short, Berlin-Baghdad . . . On the execution of this task depends the future of our race. If we fail, there is no more habitable land in the world for the Teuton to hold as master, and it will be our fate to be cultural manure." Similar ideas underlie the writings of Count Reventlow, whose very able books on "Germany's Foreign Policy" and "The Vampire of the Continent" (a polite attention addressed to England) have had infinitely greater influence on German opinion than Bernhardi's pseudo-philosophy, but have not received the same free advertisement in England. Since the war another book, entitled "The New Triple Alliance" (*Der neue Dreibund*), by Ernst Koehler, has been much discussed in Germany. The *rôle* assigned by him to Germany is that of "liberator of the Western Slavs." Russia is to be driven eastwards, Finland is to be restored to Sweden, Poland and the Ukraine liberated. This is an interesting "liberal" variation of the orthodox Pan-German view, that Galicia may well be thrown to Russia as ballast from the Austrian balloon, while the German and Slovene provinces of Austria would be included in the German Empire as a new kingdom, the Eastern Adriatic coast would become a "Reichsland" on the analogy of Alsace-Lorraine, and the Austro-Hungarian Navy would be incorporated in the German. The extreme doctrine of absorption in Germany, preached so unashamedly by the Pan-German deputies in the Austrian Parliament for years past, has to-day received a more decorous form. Instead of cheers for the Hohenzollern dynasty and an open invitation to civil war and a Prussian invasion of Bohemia, we are presented with the theory that "Austria must exist for Germany," and that "it will be Germany's task after the war to transform the old Austria into a new German Austria."

Amid all this literature one book stands out pre-eminent—"Mitteleuropa," by the Radical politician and economist Friedrich Naumann, one of Germany's sanest and most serious political thinkers. Without a trace of rant or sabre-rattling, on the basis of wide knowledge, both historical, political, and economic, and in eloquent yet sober language, he builds up an elaborate argument for the fusion and consolidation of the two Central States after the war, as a single unit with a solid front to the outer world. The Northern Powers, Holland, Switzerland, and the Balkan Peninsula are not to be included at the very outset; they still have a little time before them in which to make their choice. The essence of his plan is to create the kernel; all the rest will follow automatically. All historical particularism must be wiped out by the stress of world-war, in so far as it may interfere with the idea of unity. This war, he argues, is not merely a German war, as so many leading Germans claim, but the crucible in which "Mitteleuropa" is to be shaped. Nor must Naumann be regarded as a mere Jingo; for almost at the outset he protests against Bethmann-Hollweg's theory of the decisive struggle between Teuton and Slav and condemns it as an insult to the Czechs, Poles and Slovenes, all of whom must be brought to realise their identity of interests and common future with the Germans and Magyars. "Mitteleuropa" must be the fruit of joint economic labour, but also of joint intellectual effort, and must lead to emancipation from the spell of French and Russian influence. It means an end to the old jealousy of Prussia and Austria, of Berlin and Vienna. "An united nation of brothers" (*ein einig Volk von Brüdern*) must revive the old conception of the mediæval Empire, organised on the intensest possible modern methods. Questions of language and religion may be treated as side issues, so long as there is unity in essentials. The root fact upon which Naumann rests his whole argument is the argument that Germany must either abandon the idea of being a world power, or organise Central Europe under her ægis as an economic unit. The days of small states being numbered, and our century being marked by the development of vast world-states, "Mitteleuropa" is essential, if there is to be something

German to place beside the British and Russian Empires, the French colonial empire, China and Japan, the United States, and Spanish America, the six great organisms which the nineteenth century has formed, or which are still taking shape before our eyes. Throughout the book Naumann's tone remains eminently sane, and if all Germans shared his outlook and his moderation it is probable that there would long ago have been such a development on entirely peaceful lines. But developed further according to the tenets of Treitschke and Lagarde, of Prince Bülow and Bassermann, of Rohrbach and Schiemann, it would swiftly become a terrible danger to the rest of Europe, which is scarcely able as a coalition to resist Germany's impetus, and might be reduced to helplessness if all the resources of Mitteleuropa, including her Polish and Balkan conquests, could be organised by the relentless system of Potsdam.

Mitteleuropa is the first stage. The second—that of "Berlin-Baghdad"—is also far from new. Quite apart from Moltke's dream of a German Palestine, we find Roscher, in 1848, arguing that Turkey's heritage should fall to Germany. In 1846 List proposed the Baghdad Railway and German colonisation of Asia Minor; and similar ideas can be traced in Rodbertus, Lassalle and others. Though Bismarck affected indifference for the Eastern Question, it was his *rôle* as honest broker at the Congress of Berlin which first opened the door to German influence at Constantinople. In 1882 the first German military mission was sent to reorganise the Ottoman army; and though Von der Goltz never obtained enough power to make his reforms effective, the German military tradition was firmly established in Turkey, and with it the connection of Krupp as the furnisher of war material. In 1886 the Orientalist Sprenger published a book on "Babylonia: the richest Land of the Past and the most Remunerative Field of Colonisation in the Present," and declared it to be the sole country not yet occupied by a Great Power. Kaerger, too, advocated Asia Minor as a field of colonisation. Their writings coincide with the period when German engineers and emissaries of the Deutsche Bank were founding the Anatolian Railway Society and building as far as Angora and Konia. The Pan-Germans, of course, pushed the idea of a protectorate of Asia Minor and the acquisition of Mesopotamia and Syria. Among numerous students of the ground was an artillery officer, Kannenberg, who in 1897 published a monograph on "Asia Minor's Natural Riches," and who, significantly enough, was accompanied by an officer of the German General Staff. A year later it was William II. himself who, as the "Imperial commercial traveller," propagated the German idea in the Middle East. At Damascus he proclaimed himself the "friend for ever" of the whole Mohammedan world. At Jerusalem he chose the anniversary of the nailing of Luther's theses on the church door of Wittenberg to reiterate Luther's famous resolve "to maintain this field." In Constantinople he extracted from the blood-stained hand of Abdul Hamid, still reeking from the Armenian massacres, valuable commercial concessions for the Germans in Asia Minor. In 1899 the Porte concluded with Dr. Siemens, of the Deutsche Bank and the Anatolian Railway Company, a comprehensive contract, conceding to Germany in principle the whole railway system as far as the Persian Gulf. In 1902 the actual right of construction as far as Baghdad was also conceded. The complicated negotiations and intrigues which followed this event, and led to more than one important modification of the original contract, are not suited for treatment in a paper which covers so much ground as my present subject, and I hesitate to enter into details of which our Chairman has an infinitely deeper knowledge than I can claim. But it is essential to emphasize the need for careful study of this policy of "peaceful penetration" by which Germany prepared the way for what her leaders glory in describing as "the German War." The tireless work of the Deutsche Bank, and the brilliant writings of Von der Goltz Pasha, Paul Rohrbach ("The German Idea in the World"), Hugo Grothe, and many others, have done much to popularise the idea that Mesopotamia and Asia Minor are destined to become "an economic substitute for the lack of a German Canada or Australia," and it is essential that we should be well informed as to the views of the enemy, both before and during the war, on this subject. It is all the more essential, because the secret negotiations between the British and German Governments regarding the Baghdad railway, in the eighteen months which preceded the outbreak of war, appear to have been based upon a complete failure on the part of our leaders to comprehend the very elements of the situation in the Near East.

I cannot pretend to have offered you anything approaching a clear picture of German designs. Whether real statesmanship on our part during the years following King Edward's death would

have averted the conflict by convincing Germany that the risks of the game were too great is a question which would lead too far afield. The essential fact is that under William II. Germany has been plagued by vast ambitions and growing unrest, which finally took the form of a challenge to all Europe in arms. To-day it is no longer possible or necessary to argue about the exact strength of Pan-Germanism on the eve of war. For in war moderate counsels are necessarily thrust into the background on every side; and to-day Germany is writing the Pan-German programme in letters of blood on the face of Europe. Her alliance with Austria-Hungary has become more indissoluble than ever, and the idea of a customs union, as a final seal upon the bond, is being propagated by prominent politicians, publicists, professors and bankers. Three members of the Austrian Cabinet who opposed the idea were driven from office during last winter. Germany reorganised the Austro-Hungarian Army when it had reached breaking point, and does not mean to relinquish the control which this fact has given to her. To all intents and purposes Mitteleuropa is shaping before our very eyes. Turkey and Bulgaria are in the German grip, and the consummate folly of our statesmen in deserting Serbia and intriguing with Bulgaria has thrown away an invaluable strategic position, brought untold misery on a gallant Ally, and opened the gate to Constantinople, which it was alike our duty and interest to block. To-day we are faced by a solid mid-European *bloc* of 120 millions, which can only be shattered or pared down by military effort, but cannot be split up by diplomacy; by the maturing project of a kingdom of Poland under a German or Austrian sovereign, as an annexe, industrial, agricultural and military, to Germany; by the prospect of a Balto-Lithuanian state, also under German rule; by the certainty that Serbia will be annexed to the Habsburg Monarchy unless we can deliver her by force of arms; by the no less certain prospect of Bulgaria, under King Ferdinand, continuing as a vassal of Austria-Hungary and Germany; and of Turkey, reorganised and exploited by Berlin, becoming a constant menace to Egypt, Persia and Arabia.

This situation cannot be met by a few vague phrases about Prussian militarism, admirable eighteen months ago as a first statement of our case, but to-day worthless unless translated into more precise and concrete terms. Unless we are prepared to desert our Allies and conclude an ignominious peace with Germany, we must counter the German plan of "Mitteleuropa" and "Berlin-Baghdad" by placing obstacles in its path. Germany can only be defeated if we are prepared to back the Slavs and liberate the Slav democracies of Central Europe. Our barrier to the German *Drang nach Osten* must be sixfold. (1) Poland, freed from its long bondage and reunited as a state of over 20,000,000 inhabitants, on terms of close intimacy with Russia, will be able to develop still further her great natural riches, and to reconstruct her social system on the lines of Western democracy. (2) Bohemia, who has been the vanguard of the struggle against Germanisation for eight centuries and has proved herself the most modern, the best organised and educated, and the most virile and persistent of all the Slav races, will, as an independent state possessing natural frontiers, strong and self-supporting industries and keen national consciousness, become one of the greatest assets in the struggle against Pan-Germanism. (3) The small and landlocked Serbia of the past will be transformed into a strong and united Southern Slav state upon the eastern shore of the Adriatic, no longer seething with unrest as the result of Magyar misrule in Croatia and Austrian economic tariffs, but free at last to develop a national life which has resisted five centuries of Turkish oppression. As a second line behind these three Slavonic states, we should aim at creating (4) independent Hungary, stripped of its oppressed nationalities and reduced to its true Magyar kernel, but for that very reason emancipated from the corrupt oligarchy which has hitherto controlled its destinies, and thus enabled to develop as a prosperous and progressive peasant state; and Greater Rumania, consisting of the present kingdom, augmented by the Rumanian districts of Hungary, Bukovina and Bessarabia. Behind these again would stand Greece and Bulgaria as national states, the latter purged of her evil desire to exercise hegemony over the Peninsula. Finally, Russia would control Constantinople and the Straits, thus restoring the Cross to its true place upon the Golden Horn, and at the same time satisfying that longing and need for an access to the open sea which has underlain Russian policy for at least two centuries. As a free port for all comers, Constantinople could only gain by a Russian protectorate, and the special rights of Rumania in the Black Sea and the Straits would receive the fullest recognition.

The alarmist will seek to oppose such a programme by the argument that it involves assigning the German provinces of Austria to

Germany, and thus aggrandising an enemy whom it must be our aim to weaken by every means in our power. Such arguments are, however, entirely specious. In the first place, there is no power on earth which could keep the Germans of Austria and of the Empire apart if once they determined to unite; and it is quite impossible for us to lay down the principle of nationality as the basis of settlement and then to deny it to the most powerful and compact of all the European nations. Moreover, in the event of our victory—and all such speculation is worthless in any other event—Germany will presumably lose the greater part of Alsace-Lorraine and Posen; and thus any access of Austrian territory would leave her virtually where she was before. But the decisive reason is the fact that the sole alternative to the completion of German national unity is the survival of Austria-Hungary; and in present circumstances this can only mean the latter's reduction to complete military, political and economic vassalage to Germany. The events of the war have amply demonstrated the Dual Monarchy's dependence upon German discipline and organising talent; and, if for no other reason, this dependence will tend to increase more and more rapidly as a result of economic exhaustion and imminent bankruptcy. Possible failure in other directions will only strengthen Germany's hold upon the Monarchy, which, according to the Pan-German plan, is regarded as a fertile field for German colonisation. In other words, we are faced by the alternative of breaking up Austria-Hungary —in which case Germany obtains an addition of eight or nine million inhabitants, but is restricted to her natural limits and is surrounded by new and virile national states—or of permitting its survival, and thus securing to Germany the final assertion of political control over its fifty-one million inhabitants, and thus indirectly the mastery of Central Europe and the control of the Adriatic, the Balkans, and Constantinople.

The twentieth century is the century of the Slav, and it is one of the main tasks of the war to emancipate the hitherto despised, unknown or forgotten Slavonic democracies of Central and Southern Europe. If the Poles, the Czecho-Slovaks and the Jugoslavs succeed in reasserting their right to independent national development, and to that close and cordial intercourse with the West to which they have always aspired, they will become so many links between the West and their Russian kinsmen, and will restore to Europe that idealism which Prussian materialist doctrine was rapidly crushing out. Establish one nation supreme over the Continent, controlling the destinies of a whole group of its neighbours, and you most surely inaugurate a new era of armaments and racial strife, accentuated tenfold by revolution, bankruptcy and social upheaval. The theory of racial domination, whether it be Prussian, Magyar, Turk or Bulgarian, must be replaced by a programme of free and untrammelled development for every race. The supernation must follow the superman into the limbo of history.

The Chairman (Sir Edwin Pears), in moving a hearty vote of thanks to the author for his interesting paper, said he hardly knew what was the right adjective to apply to it: it was brilliant, it was academic, it was thoughtful; and it suggested that English people had not given the amount of thought that they ought to have given to the subject. It did not follow, of course, that they were all bound to agree with every proposition put forward by the author. The author had alluded to him as knowing something about the development of the railways in Asia Minor, and it was true that he had watched the question "from Berlin to Baghdad" during the last thirty years. Twenty-five years ago he was strongly urged by Austrian friends to buy land in Macedonia, for they said that Austria was going to annex Serbia, reach Salonica, and take possession of all that part of the country within five years. He was glad to say he did not take their advice, but the constancy and persistency of the idea of Austrians and Germans that Serbia was in the hands of Austria, and that Austria could annex Serbia whenever it liked, was astonishing to those who knew the country. Five years ago he met, at a well-known club in London, the representatives of four of the leading papers of Vienna and Budapest, one of whom said to him: "You know you in England over-estimate the power of Russia enormously. As for our being able to annex Serbia, we can have it when we like, and you are mistaken in thinking that Russia could stop us." He turned to the other three and asked them if that was their opinion too, and they all said, "Yes, undoubtedly Serbia is in the grip of Austria and cannot escape from it." With regard to the construction of the railway from Constantinople towards Baghdad and the Persian Gulf, he was concerned in the Arbitration on behalf of the British and Austrian subjects who were dispossessed of their land at the head of the line, between Constantinople and Ismid, and obtained £133,000 as compensation for them, but the Germans got the line all the same. The various rumours that had been circulated about Enver Pasha were nonsense; he had really been to the Taurus to see whether the tunnels had been completed and were ready for the passage of the troops. Once the mountain tunnels had been made, it was

an easy matter to reach Aleppo, and to continue on to the Euphrates. A friend had driven his motor-car from Smyrna to Baghdad and declared that there was no finer ground in the world for motoring over than the desert there; it was just of the right consistency and flexibility. If the Government would spend a few hundred pounds in repairing the roads to the river-bed and up again on the other side, that journey, which now occupied three weeks or a month, could be performed in four days. The railway there was rapidly being completed, but neither that railway nor the English irrigation scheme would convert Mesopotamia into the paradise that the Germans imagined. The railway would be of advantage to the peasants of the country, as it would enable them to convey their produce to market, and in that connection he had nothing to say against the Germans, as it was a case of peaceful penetration. Great efforts had been made to plant German colonies along it, but they would all fail from beginning to end. He knew Palestine fairly well, and could say with certainty that, except for two or three settlements of Second Adventists, there were no German colonies in Palestine. He had no objection to peaceful penetration by Germany, but when it came to a question of a railway from Berlin to Baghdad, destroying the hegemony of Serbia, of Macedonia, of Turkey, and so on, that was a matter that should be strenuously opposed.

The resolution of thanks was carried, and the meeting terminated.

GENERAL NOTES.

INSTITUTION OF NAVAL ARCHITECTS.—The annual meeting of the Institution will be held in the hall of the Royal Society of Arts on Wednesday, April 12th, and Thursday, April 13th, commencing each morning at eleven o'clock. The usual annual dinner and evening reception will not take place this year. A list of the papers to be read will be found in the usual list of meetings at the end of next week's *Journal*.

CANADIAN FISH.—The first big consignment of Canadian fish for the Canadian troops now in Europe has lately arrived in England. It is made up of salmon and halibut from the Pacific Coast and soles from the Maritime Provinces. Another shipment will contain lake whitefish and herring from Lake Superior, and about forty tons of lake and sea fish are to be sent over weekly. They are all frozen, and sent to St. John in cold-storage cars, and then put into the cold storage of the ship, so that they may arrive at the camps in a frozen condition, just as the soldiers have been used to having them at home.

MEETINGS OF THE SOCIETY.

ORDINARY MEETING.

Wednesday afternoon, at 4.30 p.m.:—

APRIL 5.—ARTHUR S. JENNINGS, "Painting by Dipping, Spraying, and other Mechanical Means." Major P. A. MACMAHON, R.A., LL.D., D.Sc., F.R.S., will preside.

FOTHERGILL LECTURE.

Monday afternoon, at 4.30 p.m.:—

EDWARD A. REEVES, F.R.A.S., F.R.G.S., "Surveying, Past and Present." Three Lectures.

Syllabus.

LECTURE II.—APRIL 3.—*Present position of Surveying and Mapping of the World.* General account, illustrated by maps and diagrams showing (1) parts of the world topographically mapped from reliable surveys, (2) those less accurately mapped from surveys chiefly non-topographical, (3) parts only roughly mapped from route traverses, and (4) those still entirely unsurveyed—Facsimiles of MS. maps of well-known explorers—Specimens of different kinds of surveys from which the earth has been mapped, with general account of them—Part taken by the Royal Geographical Society in promoting exploration and surveying—Work of the future.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 3...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Fothergill Lecture.) Mr. E. A. Reeves, "Surveying: Past and Present." (Lecture II.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. Professor D. S. Margoliouth, "The Influence of German Philosophy in bringing about the Great War."

Electrical Engineers, Institution of (Local Section), Technical College, Bristol, 5.30 p.m. Mr. H. Joseph, "Hire and Maintenance of Continuous-Current Motors."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Society of, Caxton Hall, Westminster, S.W., 5.30 p.m. Mr. J. E. Lister, "Modern Coal and Coke Handling Machinery."

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m.

Geographical Society, Burlington-gardens, W., 8.30 p.m. Colonel Sir Thomas Holdich, "Geographical Problems in Boundary Making."

TUESDAY, APRIL 4...Sociological Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Dr. C. W. Saleeby, "Imperial Eugenics."

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. Keeble, "Modern Horticulture. Lecture II.—Growing Time and Seed Time."

Alpine Club, 23, Savile-row, W., 8.30 p.m. Mr. J. Stogdon, "Random Memories."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. 1. Discussion on Sir G. C. Buchanan's paper, "The Rangoon River-Training Works." 2. Mr. R. F. Grantham, "The Present Conditions of Arterial Drainage in some English Rivers."

Zoological Society, Regent's Park, N.W., 5 p.m.

Röntgen Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8.15 p.m. 1. Mr. J. P. Neate, "A Chronograph constructed to work with the Electroscope." 2. Messrs. B. H. Morphy and S. R. Mullard, "The Enclosed Tungsten Arc as a source of Ultra Violet Light." 3. Mr. E. Schall, "Experiments with a Coolidge Tube." 4. Mr. H. E. Donnithorne, "A New Modification of the Ionization Method of Measuring X-Rays." 5. Exhibition of Plates showing "Experiments with the Coolidge Tube in Radiography."

WEDNESDAY, APRIL 5...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. A. S. Jennings, "Painting by Dipping, Spraying, and other Mechanical Means."

Civil Engineers of Ireland, Institution of, 35, Dawson-street, Dublin, 8 p.m.

Geological Society, Burlington House, W., 8 p.m.

Sanitary Engineers, Institute of, Caxton Hall, Westminster, S.W., 7 p.m. M. Andre Le Marchand, "Planning for a Manufacturing Town of 50,000 Inhabitants."

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. W. R. Schoeller and A. R. Powell, "On the Alkalimetric Estimation of certain Bivalent Metals in the form of Tertiary Phosphates." 2. Mr. P. A. E. Richards, "Note on a Specimen of Russian Oak." 3. Mr. A. H. Bennett, "The Estimation of Potassium in presence of other substances."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. 1. Dr. A. C. Fryer, "The Monumental Effigy of Bridget Countess of Bedford at Chenies." 2. Dr. P. Nelson, "The Effigy of a Thirteenth-Century Abbot of Ramsey. Some further examples of English Mediæval Alabaster Tables."

THURSDAY, APRIL 6...Faraday Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. W. Rosenhain, "The Making of a Big Gun." (Illustrated by cinematograph.)

Royal Society, Burlington House, W., 4.30 p.m.

Linnean Society, Burlington House, 5 p.m. 1. Professor G. C. Bourne, "On Five New Species of *Edwardsia*, Quatr." 2. Professor W. J. Dakin, "A New Species of Enteropneusta from the Abrolhos Islands." 3. Dr. O. Stapf, "The Southern Elements of the British Flora."

Chemical Society, Burlington House, W., 8 p.m. 1. Mr. J. N. Collie, "A space formula for benzene." (Part II.) 2. Earl of Berkeley, "A new form of distilling flask, together with a note on benzyl benzoate." 3. Mr. J. W. Smith, "3-Phenanthrol-4-aldehyde."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. Hadow, "English Music in the Tudor Period. Lecture II.—Secular Part Music."

FRIDAY, APRIL 7...Royal Institution, Albemarle-street, W., 5.30 p.m. Mr. W. S. Lilly, "A Plea for War."

Engineers and Shipbuilders, North-East Coast Institution of, Newcastle-on-Tyne, 7.30 p.m.

Geologists' Association, University College, W.C., 7.30 p.m. Mr. M. Odling, "Notes on the Corallian of the Oxford District, with special reference to the Occurrence of a Pebble-bed at a Constant Horizon."

SATURDAY, APRIL 8...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Radiations from Atoms and Electrons." (Lecture V.)

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FRIDAY, APRIL 7, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, APRIL 10th, 4.30 p.m. (Fothergill Lecture.) E. A. REEVES, F.R.A.S., F.R.G.S., Map Curator and Instructor in Surveying to the Royal Geographical Society, "Surveying: Past and Present." (Lecture III.)

TUESDAY, APRIL 11th, 4.30 p.m. (Colonial Section.) SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Forest Resources of Newfoundland." THE RIGHT HON. SIR WILLIAM MACGREGOR, G.C.M.G., C.B., LL.D., D.Sc., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

COLONIAL SECTION.

Tuesday afternoon, March 28th, 4.30 p.m.; DUGALD CLERK. D.Sc., F.R.S., Chairman of the Council of the Society, in the chair. A paper on "Next Steps in Empire Partnership" was read by PERCY HURD, joint author of "The New Empire Partnership: Defence, Commerce, Policy."

The paper and discussion will be published in subsequent numbers of the *Journal.*

FOTHERGILL LECTURES.

On Monday afternoons, March 27th and April 3rd, 4.30 p.m., Mr. EDWARD A. REEVES, F.R.A.S., F.R.G.S., Map Curator and Instructor in Surveying to the Royal Geographical Society, delivered the first and second lectures of his course on "Surveying: Past and Present."

The lectures will be published in the *Journal* during the summer recess.

JOURNAL.

The Government limitations on the importation of paper and paper-making materials have rendered it necessary to restrict the *Journal* to the smallest possible size. For the present, therefore, its contents will be confined as far as possible to a report of the actual proceedings of the Society, and it may be necessary occasionally to publish reports of the meetings a little less promptly than has always been the practice.

It is hoped that the Fellows will appreciate the necessity of such restrictions, and it is also hoped that the *Journal* may be able to expand to its normal size at an early date.

PROCEEDINGS OF THE SOCIETY.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 5th, 1916; MAJOR PERCY A. MACMAHON, R.A., LL.D., Sc.D., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Donelan, Dermot O'C., J.P., Regent Palace Hotel, Piccadilly-circus, W.; and Sylanmore, Tuam, Co. Galway, Ireland.

Phillips, S. Charles, M.S.C.I., 47, Cannon-street, E.C.

The following candidates were balloted for and duly elected Fellows of the Society:—

Deb, His Highness Raja S. Tribhuban (of Bamra), Bamra, Deogarh P.O., Sambalpur, India.

Major, John Grayling, Clevedon Lodge, West Park, Eltham, Kent.

The paper read was—

PAINTING BY DIPPING, SPRAYING, AND OTHER MECHANICAL MEANS.

By ARTHUR SEYMOUR JENNINGS, F.I.B.D.

It may safely be taken as a fact beyond doubt that the application of paint, japan, enamel and varnish by mechanical means, in contradistinction to the old-fashioned method of using brushes, effects an enormous saving

of time, and to some extent of material also. It should also be recognised that the result from the point of view of both durability and appearance is a distinct improvement on the older method. In the United States of America dipping, paint-spraying, and the application of paints and varnishes by other mechanical means are employed almost universally in the industries, and in this country such methods have been successfully used in certain factories for many years past. Of late there has been a remarkable increase in this direction in the United Kingdom, although there are not a few manufacturers who still seem slow to adopt modern methods.

It is remarkable to note that a great number of firms who have given some consideration to the subject are inclined to the idea that while paint or its equivalent may be successfully applied by mechanical means in other industries than their own, it is not suitable for the particular one in which they are engaged. Closer examination, however, proves that there are very few trades indeed using paint in which the processes may not be successfully employed, and it may surprise some of those present to learn that in at least 250 different industries dipping or spraying may be successfully and economically employed. A few of these may be mentioned in order to indicate the diversity of the articles dealt with. Paint is applied by dipping to agricultural implements on a very large scale, to casements, bedsteads, piano cases, barrows, reaping-machines, cans and a great many other articles. By spraying, paint, varnish, japan and various other protective liquids are applied to shells and to confectionery, to celluloid buttons and to motor-cars, to bird-cages and to dynamos, but the list could be extended almost indefinitely.

In my investigation of the subject I have come across a few firms who have tried one or other of the methods mentioned, but have abandoned them on the ground that the result has not been satisfactory—never, be it remarked, because they were found to be too expensive. Investigation has proved that such cases of failure have arisen either because a suitable apparatus was not chosen for the particular work in hand or the right sort of paint or japan was not used. The last cause of failure is the most frequent, as, for instance, a case placed before me some time since, in which small iron castings were painted by dipping but were found to stick together and not dry properly. Here the japan used was not suitable for the purpose, and it will be readily seen that paint or japan which might answer well if applied by means of a brush would not be suitable for application by dipping.

Without going at this stage into the question of other failures, it may be remarked that an idea prevails that the cost of plant necessary for carrying out these processes is prohibitive. This is altogether a mistake. A spraying machine with the necessary plant could be purchased for £30 or £50, although a large plant would, of course, cost very much more. The same is true in the case of dipping. If the articles to be painted are very large and very elaborate, the plant will obviously be somewhat expensive. For many purposes the tanks, hoists, etc., may be of a very simple character, as, for example, iron and steel sashes which are dipped into a narrow tank containing paint would require only a simple form of hoist with hanging rails and metal dripping floor adjoining the tank; or, simpler still, a mere boxlike tank, in which tapered varnish and paint cans are dipped by hand, a piece of wood being inserted in the neck by which to lift them in and out. The cost of such a plant need only amount to a few shillings.

It will be convenient now to divide the subject up under various heads, viz., (*a*) painting by immersion; (*b*) by spraying by means of compressed air; and (*c*) other mechanical means.

Taking these in order, a dipping plant usually consists of a tank (preferably metal lined) which contains the paint or varnish into which the article to be painted is plunged bodily. Clearly it must be of sufficient size to hold easily the article to be dipped. In the case of agricultural machinery, farm and military waggons, etc., the size and depth have to be considerable, and in this case, as a rule, an agitating apparatus at the bottom is desirable. One form consists of a shaft passing from end to end at the bottom of the tank, and provided with a paddle, while over it is provided a metal frame which may be roughly described as a horizontal venetian blind, the slats of which may be turned vertical when the agitating apparatus is working. This fitting is provided with the object of preventing the paddles being clogged by the settling paint, but it also serves to catch any pieces of wood, nails, etc., which may accidentally find their way in. As a matter of fact, a good dipping plant does not settle out to any extent, and it is sufficient if the agitating apparatus is operated each day for twenty minutes or so before starting work, and for a somewhat longer period on Monday morning.

Another form of agitating apparatus is

provided with a worm for agitation instead of a series of paddles.

As already indicated, for dipping such articles as iron sashes a very narrow but deep tank suffices, and in this case, as in many others, the agitating mechanism may be wholly dispensed with, because it must be remembered that the mere fact of plunging an article into the paint and immediately withdrawing it has the effect in itself of stirring up the paint.

Iron bedsteads are coated nowadays almost invariably with paint or japan by plunging the parts into japan, and these are afterwards stoved or baked. Iron frames of mangles and many other similar parts are also painted by dipping. Perhaps no better illustration could be given of the high degree of finish obtainable by dipping than the fact that piano cases may be finished by the method, the parts being lowered bodily into the varnish tank. Time will not permit me to give the details of the process, but I may state quite definitely that the finish is quite as good as that obtained by the use of brushes, and that the extra amount of varnish required is only about 5 per cent. I would very emphatically state that if the very fine finish which is necessary for pianos can be obtainable by dipping there can be no paint, varnish or japan finish too difficult to obtain by the method. In effect, it simply means a careful study of the requirements for the particular work in hand.

Adjoining the tank must always be an inclined metal-lined floor, over which the articles can be held to drip for a few minutes, and this floor should be connected with a trough leading to an underground tank to hold the superfluous paint, which should pass through a grating and may be pumped into the main dipping-tank as required, or, if desired, the arrangement may be such that the superfluous paint drains directly into the dipping tank.

Just as the size of the tank will vary with the dimensions of the object to be dipped, so will the type of hoist employed differ according to circumstances. I have seen a rope over a pulley used for very simple work, such as bedsteads, but as a rule a pneumatic or electric hoist is the cheapest in the end, particularly if it is worked in connection with a trolley, because it must be remembered that it will be necessary to provide a more or less elaborate system of overhead rails on which the articles can be hung to dry after dipping.

As a rule, the paints employed are sufficiently hard to receive a second coat within, say, four hours; and the system adopted at Woolwich Arsenal is a very good one, which may be confidently recommended. Two tanks are provided, one at each end of a very long room with rails between. The waggons are dipped at one end, proceed very slowly towards the other end of the room where they are sufficiently dry to receive a second coat, and on turning receive a third coat at the first tank.

I should like to emphasize the importance of a careful consideration being given to the question of the overhead rails, as I find from my inspection of a large number of factories that many of them are quite deficient in this respect. As in all details of engineering works, a saving of labour is essential to economy, and it is well to have the rails so arranged that the work passes from the finishing-room to the tank or tanks, and thence to the storage or shipping department. If this is done on a well-thought-out basis great speed can be effected.

It will be understood that the article being painted remains in the paint only a few seconds, that it is then stationed over the dripping floor for perhaps five minutes, and then proceeds along the rails for further treatment until it is finished. The question will at once occur whether this method does not produce drips, or what painters call "fat edges." The answer is, that if this occurs the paint is not properly made for the purpose. As a matter of precaution, one painter usually stands by each article as it is suspended over the dripping floor, and with a brush removes any small drips or fat edges which may occur. This labour, however, is very slight. Sometimes it is desired to put on a different-coloured finish to the work than that which is put on the under-coats; it is clear that this may be effected by using a different tank.

Before proceeding to describe paint-spraying or painting by means of compressed air, it may be convenient to compare the method with that of dipping. Without dwelling at any length on the subject, which is of a somewhat controversial character, it can be stated briefly that in arriving at a decision as to the respective merits of the two processes, one can only be guided by the shape and size of the particular article which is to be painted. A reaping-machine, for instance, is of so intricate a character that plunging it bodily into the tank is certainly preferable to spraying; on the other hand, there are many articles where spraying produces far better results than the dipping process. Sometimes both methods are used in conjunction; for example, the first or priming coat can be given by dipping and the final coat of varnish sprayed

on. Again, spraying can be used in cases where the whole article is not required to be painted, as, for instance, the body of an automobile, which if plunged would receive paint on the inside as well as the outside, which is not desired. A better way would be to spray over the whole of the outside surface, although this method, as I shall explain later, has to some extent been superseded.

There are about a dozen different makes of paint-sprayers on the market. It is hardly within my province to recommend any one of these as being superior to the rest, but those interested should carefully compare the construction and first cost before arriving at a decision as to adopting either. With one or two exceptions these machines all work in the same manner. Paint, varnish or other liquid is contained in either a cup attached to the spraying apparatus when the quantity required is small, or in a small tank connected up with tubing. Take, for example, the "Aerograph," which was the first of its kind placed on the European market. It is also the one which will be used in the demonstration which will follow my remarks. A cup containing the paint is screwed on when only a little paint is required, but when the supply is to be continuous a cap fits in the same position, and the paint comes through a supply tube. The air is supplied through a flexible tube, and there is a finger lever which controls both the air valve and the colour valve in the nozzle, so that little or much paint may be allowed to pass into the current of escaping air. This may be considered to be a general principle upon which all these sprayers work, with one or two exceptions. The amount of air pressure varies very largely with the consistency of the paint, but, generally speaking, thin liquids and varnishes may be sprayed with 18 lb. to 20 lb. to the square inch, while a maxmium of 50 lb. will cover nearly all classes of paint and similar products. In cases of very thick liquids heat may be applied to the paint tank, which will facilitate the operation to some extent.

The next sprayer is known as the "Midland." Its claims to superiority are chiefly simplicity of construction, solidity of working parts and ease of cleaning.

Another form of sprayer is the "Invincible." This instrument is so arranged that it may be used with the air pressure only if required to dust the article about to be painted.

The "Airostyle" is the next type of sprayer shown. It is made in various patterns and sizes for use with different kinds of work, and is one of the most popular instruments of the kind on the market.

The "Aeron" is another type, and the spraying is done through the cup holding the paint, excepting in the case of a considerable amount of work being done, when the paint will be placed in a container holding several gallons and held in an elevated position.

The "Eureka" is constructed on an American model. It is used with the cup only and is conspicuous for the absence of complicated parts. It is very suitable for work in which it is desired to change the colour frequently, as any number of cups filled with different colour may be on hand and the transfer from one to the other takes but a minute or so.*

Having briefly described the principal spraying apparatus available the next provision necessary is (a) the supply of compressed air, (b) the exhaust, and (c) the cabinet in which the spraying is done and which should be fitted with a turntable. There are various forms of air compressors, ranging from a small and simple one for a single spraying apparatus up to those larger and more elaborate which are required where a number of sprayers are in use. The compressors must be designed to give an absolutely pure supply of air, free from oil and grit, and the air-main must be so arranged as to avoid any trouble due to condensation. For high-class work a suitable air filter should be fitted to the intake of the compressor. It should be of large diameter, and have a gauze screen and wad of cotton wool.

As already intimated, the spraying should be done in a cabinet fitted with an air exhaust. Unless this is provided the operator may be seriously injured by inhaling the fumes from the paint or varnish or the paint itself. The exhaust is usually produced by fans, and in large works the exhaust main connects up with all the different cabinets. This question of masks is one which solves a good many of the problems surrounding the subject of paint spraying. By using masks or stencils, or both, almost any work can be done. For instance, I was recently consulted by a toy manufacturer in a large way of business as to the most economical method of painting red lines on iron parts of toy standards. I recommended a spraying machine to be used with stencils of thin metal through which the lines should be cut with breaks at intervals to hold the stencil together. Going back for a

* Slides showing the various forms of apparatus were shown.

minute, it may be mentioned that in dipping articles into paint any portion which is not required to be painted may be protected by the application of a little vaseline, and this can be rubbed off when the rest of the work is dry.

Before leaving the subject of spraying, a few words may be said as to another type of apparatus used in the open for sixteen operators on small work. These cabinets are fitted with glass sides, and it may be here mentioned that ample light, either natural or artificial, must always be provided, as otherwise some part of the work to be sprayed is nearly certain to be missed. The light should be derived from the left side of the operator or from overhead.

There are so many trades in which spraying is successfully done that it is difficult to select any one as being of special interest. A simple operation is that of painting or repainting gas-meters. In this case some parts of such work, as for instance the brass labels and name-plates, are not required to be painted. To protect them a mask of suitable shape is used. They are held in position by the stout wire appendage, and are readily put on and taken off. When it is desired to paint a very large surface, such as a gasometer, or a series of iron girders, or even a long stretch of fencing, it can best be done by using a portable spraying apparatus with motor sprayer and everything else required mounted on a platform or wheels, so that it may be moved along as the work proceeds.

An extremely interesting paint-sprayer is that designed and used by the Pennsylvania Railroad. Mr. M. E. McDonnell, Engineer, wrote: "The company does very little painting by dipping. The spray process is, however, used very extensively, a large percentage of our freight cars having been painted by this method for years. The method is very satisfactory and also economical. The saving in the cost of labour in the spraying method is approximately 60 per cent. In some cases the saving is greater than this. In one of our largest shops the cost of application per unit for a given number of square feet is $38\frac{9}{10}$ cents with the spray, as compared with \$1 with brush. It might be said that more paint is applied per coating when the brush is used. A given surface which would require 10 gallons of paint for one coat by the brush method would require approximately 7 gallons by the spray method. When painting a freight car a more uniform coating is obtained when the brush is used, due to the fact that the paint can be brushed out behind ladders and other things which would obstruct spraying, while in the application of the paint with a sprayer it is necessary to apply a thicker coating at certain points in order to reach other points which are obstructed, and which must, therefore, be approached from a side angle. The spray, however, reaches certain crevices which cannot be reached with the brush, and this is in some cases advantageous with the painting of freight equipment cars. Our company would not consider returning to the brush method of painting."

I may add to these remarks that rapid as the increase in the use of paint spraying has been of late in this country, I am convinced that there is an enormous field yet untouched, particularly in connection with portable apparatus.

Turning from comparatively rough work for a moment to the most artistic, it need hardly be said that paint-spraying may be employed for the most delicate artistic work, from retouching photographs to designs on pretty well any material.

As to the best paint for use in dipping and spraying, I need only say that ordinary paint will not answer, as a rule, because it is not of the right consistency. Supplies should be obtained ready for use or ready to be thinned by the addition of turpentine or white spirit from firms who have made a special study of the subject.

A few words now as to the method of painting or enamelling very small articles such as hooks and eyes, small castings and parts; no better method is known to me than the use of the "tumbler," which in form is similar to an ordinary churn. Inside this machine are placed a number of shot or steel balls of different sizes. The articles to be treated are then introduced, together with the japan, and the machine is started at varying degrees of speed. The shot carries the japan over the various parts and into the interstices. As different objects and materials require different speeds, some work will be started slowly and the speed increased to get the desired finish. The objects are then dumped out on to wire screens or baskets, and shaken, when the steel balls and shot fall through the mesh, leaving the articles that have been japanned behind. The baskets are then hung in baking ovens while the balls are washed in gasoline ready for use.

In order to obtain the exact amount of japan required for a given quantity of articles, the weight is taken of such articles, of the steel balls and of the japan. After a little experimenting the proportions may be formed which will result

in all parts of the articles being covered with japan without leaving any surplus whatever.

Shells.—It need hardly be said that the subject of painting shells inside and out is of great interest in these days. The paint or varnish is applied to prevent the shell rusting, and the constituents of both materials are usually settled by the War Office specifications which, however, vary considerably. White lead must not be used for the paint, zinc oxide is usually preferred, and this may be followed by yellow ochre or other earth colours, or lamp-black may be mixed with the zinc oxide to produce grey. The varnish is usually fairly cheap copal, which can be stoved or baked at a heat up to 300° F. The painting outside can be done by dipping by the aid of suitable mechanism, but the varnishing of the inside surface is more difficult. A brush or swab is sometimes used. The simplest plan is to place the shell upside down over a vertical rod communicating with the force-pump. A single plunge will send the varnish to the upper end and the inside of the shell, the varnish runs off back into the tank and the shell is then removed and placed on an adjacent perforated table to drain. Another practical method is to use an ordinary spraying machine with an extension which reaches all parts of the interior. This method is employed at the present time in many munition factories. Shellac spirit varnish is often used for small shells, and this should be slightly warmed as well as the shell itself into which the shellac may be poured and then be inverted to drain.

In a machine which is made by the Spray Engineering Co., of Boston, Massachusetts, U.S.A., an ingenious device is provided for admitting only a fixed amount of coating material at each operation. The exact amount is ascertained, the mechanism is then set to repeat precisely the same quantity, and the machine once so adjusted can be worked by an unskilled operator. The actual spraying is practically instantaneous, so that the speed is determined by the rate at which the shells are fed to and taken from the machine. What is known as Type A machine has a speed of forty miles per minute. The standard machine consists of a table with steel-supporting frame, the operating mechanism being mounted beneath the table top. The usual coating material, such as varnish, asphaltum, paint, and similar special compounds, is carried in a reservoir supported above the operating table. The liquid coating material passes down the hollow reservoir support to an adjustable measuring device controlling the amount of material sprayed at each operation. A system of levers controls the motion of the device which cuts off the supply from the reservoir and admits the measured quantity of material to a channel leading to the spray nozzle. The last part of this motion admits a compressed-air supply which drives the coating material through the spray nozzle and distributes it evenly over the surface to be coated. High working speed is thus obtained without waste of material, and one setting of the measuring device ensures the delivery of a fixed quantity of coating material to each shell.

The slide shows a general idea of the appearance of the machine and the working parts are lettered. It will be observed that the actual operation of discharging the varnish or other compound is effected by operating a foot lever.

The next slide shows Type B machine, which is adapted for coating uniformly the interior of deep shells from 3 in. to 6 in. in diameter as well as cartridge-cases for the various types of shells not exceeding, approximately, 3 in. in diameter. One feature of the machine is a moving nozzle automatically controlled. The coatings are applied to the article while in a stationary vertical position.

Type C.—This machine is designed for coating the outside of shells and cartridge-cases not exceeding, approximately, 3 in. in diameter. It is equipped with a motor-driven rotating shell table, also an exhaust fan mounted in a sheet-metal hood for protecting the operator from the paint fumes. The coating is applied while the shell is being rotated in a vertical position.

Type D.—This machine is designed for coating the inside of shells larger than 6 in. in diameter, and of those that are too heavy and too long to be handled in a vertical position. A motor drive is included for rotating the shell, also an exhaust fan as noted under Type C machine. The shell is laid on its side and rotated in a horizontal position during the coating operation. The nozzle, while spraying, is moved automatically along the shell axis, thus ensuring the uniform coating over the entire inside surface.

It is important to observe that before paint or varnish is applied it is essential that the surface be absolutely clean and free from grease. With this object the shells are boiled in a solution of caustic soda, and they are then thoroughly washed in clean water. Any shells which have been improperly varnished are boiled for as long

as three hours, which is sufficient to remove the varnish and render the shells ready for treatment again.

The next two slides are included by permission of the editor of *Machinery*, and are taken from a reprint of articles which appeared in that publication on "High Explosive Shells." The first illustrates the varnishing-room viewed from the stove end, and the second the same room viewed from the preparing end. The procedure, according to *Machinery*, is as follows: "The chamber is wiped out perfectly dry on the bench at the far end of the room. The shells are transferred to the next bench, where the thread guards, termed ferrules, are screwed in. The shells are then pre-heated in the stove, withdrawn, set on the opposite of the bench, where they are filled with copal varnish, which is then poured out. They are now passed to the special bench in the foreground and located nose down to the drain. The surplus varnish falls into a tray inclined in the direction of the varnish tank, into which it flows. The varnished shells are removed on a special trolley and then transferred to the stove. The capacity of the trolley is 120 shells, and the general equipment of the room is adapted for 120 shells at a heat. Baking lasts two or four hours under a temperature of 300° F. According to official regulations, the time under this temperature must not be less than two hours. At the completion of this process, the trolley is transferred to the dispatching end of the building through the exterior doors of the stove. The shells are taken in hand by women who remove the thread ferrules and tap out varnish which may have entered the threads—not forgetting the small hole for receiving the fixing screw."

In conclusion, I should like to refer to the most up-to-date method of painting the bodies of motor-cars. The method is extraordinarily quick, a coat of japan being given to a four-seated car in exactly two minutes. This is done by discharging japan through a flexible tube connected with a overhead tank through a wide nozzle, which is opened by the pressure of the thumb and closed by a spring. The motor body is placed on a bogey with a trough-like tank on three sides of it and a solid iron sheet on the fourth side. On pressing the lever the japan literally pours out of the nozzle on to the work, and it is only necessary to move it very quickly in order to get the whole of the surface covered in the time named. Of course, a great deal more japan passes into the trough-like tank than goes on to the body, but this passes through a screen, and descends into a small tank below, whence it is pumped up to the elevated tank for use again. A few minutes are given for all superfluous japan to run off, and the bogey is then wheeled over to the stove where the body is placed for some hours until the coat is sufficiently hard to enable it to be rubbed down and then to receive a second coat in the same way.

A somewhat similar but improved method of painting motor bodies is largely used in America and is known as the "Aeron." In this process the paint, japan or varnish is forced through a flexible tube, and is discharged continuously through a wide flat nozzle. A trough-like tank is provided into which the superfluous japan flows, but sufficient sticks to the surface to give a good thick and durable coating. In order to prevent the inside of the body being splattered with japan a brush is first used to apply it to the top edges and then the nozzle is passed rapidly over the surface on to which it discharges the japan. The superfluous material which flows into the tank passes through a filter and is used again, being continuously added to that in use. The body is allowed to drip for some minutes, and is then placed in a drying oven specially for the purpose to exclude humidity. The varnish coat dries in rather over four hours and may then be rubbed down lightly either with fine steel wool or pumice stone, when it is ready to receive another coat.

I am indebted to the *Iron Age* of New York for the illustrations and the following details of the process of finishing an aluminium body, for it will be understood that nearly the whole of the materials for the undercoats are applied by means of the "Aeron." The aluminium body is first washed with gasoline applied with a brush, and this is wiped off and allowed to dry. A coat of oxide of iron priming and linseed oil is then given by means of an ordinary sprayer or air brush and the body is then placed in a stove at 115° F. for three hours. It is then ready to receive a coat of coach putty, which is applied by hand, the object being to obtain a level surface. This dries in the air for twelve hours. Then a coat of half white lead and half rough-stuff is sprayed on and the body is stoved at 115° F. for three hours. The next process is to spray on four coats of rough-stuff and to stove each at the same heat for two hours each. Next is applied by hand a coat of rubbing rough-stuff, which is air-dried and then rubbed down with pumice stone. Some additional puttying is then usually required. The body is now in a condition to receive the first coat of colour,

which is sprayed on, and this is allowed to dry in the air for six hours. The "Aeron," or flowing machine, is then employed to put on three coats of colour and varnish or enamel, the first two being stoved at 120° F. for four hours, and the last at 125° F. for four and a half hours. A coat of rubbing varnish is then applied, and this is rubbed down with finely-powdered pumice stone applied by means of a felt pad moistened in water. A final washing-off with clean water and the body is ready for the finishing coat of varnish, which is applied by experts with the usual form of flat varnish brush. The body is then complete, and provided that good materials have been used shows up with that brilliant finish which is so much admired.

Although there appears to be a large number of coats necessary for obtaining the beautiful finish there are, as a fact, fewer than would be required by the old process of applying all the coats by hand. By using the methods described, not only is a great saving of time effected, but the appearance of the finish is improved, while, more important still, the durability is distinctly increased.

In conclusion, I desire to emphasize two important provisions which are absolutely essential to a good finish and speedy work. The first is to provide a room in which the paint and varnish is applied that is well ventilated, free from draughts, and is kept at a uniform temperature. But above all, dust must be absent and the greatest care be taken to exclude it. I have seen painting shops adjacent to the joinery works with but little division between the two. The result, of course, is that specks innumerable settle upon the work, and the finish is spoiled. I would repeat, then, that too much care cannot be taken to eliminate dust.

The second provision is a drying-room, which will facilitate the drying and exclude moisture.

[At the conclusion of the paper a demonstration of the working of the Aerograph was given. Mr. Burdick, the inventor, kindly provided the necessary apparatus, by which coats of paint and varnish were successfully applied to various articles.]

DISCUSSION.

MR. WALTER F. REID, F.I.C., believed that the method of painting by means of a spray was first used at the Chicago Exhibition, as the Secretary of the Society, Sir Henry Trueman Wood, could probably testify. The story he heard was that the painters struck work when the Exhibition was nearly finished, and the man in charge of the fire-engine suggested it should be used for spraying on the paint. The suggestion was adopted, and the strike was broken. At the St. Louis Exhibition practically all the buildings were coated by the spraying method, and an enormous amount of money was thus saved. The method ought to be used to a much greater extent in this country, as it saved a large amount of labour, and effects were obtained with it that could not be produced in any other way. Much time was saved by its use in the painting of shells, and the work was done more accurately, but the author was incorrect in his statement that zinc or ochres might be used as pigments for that purpose. A zinc pigment inside a shell in which picric acid was to be placed would be a source of very considerable danger. Many years ago he worked out the composition of a paint for use in the coating of the insides of shells, which consisted of a tough varnish and contained no pigment at all. It was essential in loading a shell that the picric acid should not come in contact with the steel because it would form picrate of iron, which was exceedingly sensitive, and the varnish protected the metal from the action of the picric acid. The floor-cloth industry, in which he was particularly interested, probably consumed more paint than any other industry, apart from the painting of buildings. Although experiments had been made in the use of paint-spraying for that purpose, he had not heard of any instance in which the method had been practically adopted, and it would be interesting to know if the author had any information on that subject.

MR. CHARLES L. BURDICK said the paint-sprayer with which the demonstration at the meeting was being conducted was one in which the inner nozzle was a pin-valve controlled by a lever, the discharge port being surrounded by a ring of air. That was the only type of spray which had ever been successfully used for painting purposes. Another type of spray was used in the whitewashing machine, consisting of a force-pump with a nozzle which ejected the material in a cone shape. That was quite satisfactory for light material, and it was used at the Chicago Exhibition for whitewashing the buildings, when, owing to insufficiency of time, it was impossible to carry out the intention of painting them. But such an apparatus was not sufficient for handling oil paint, and it did not control the quantity of material used. The pin-valve arrangement with the lever controlled the amount perfectly, so that a golf ball, a lead pencil, or a ship, could be painted by such means.

MR. A. S. JENNINGS, in replying to several questions asked by members of the audience, said it would be necessary for the engineer who designed the plant for a particular piece of work to decide at what distance from the generating plant the spraying machine could be worked. The manufacturers of the spraying machines would give the best advice on that subject to those who

wished to use them. He was much obliged to Mr. Reid for pointing out the erroneous statement made in the paper in regard to zinc. As far as he knew, spraying was not used in the painting of floor-cloth in this country, and there seemed to be an immense field open for a successful application of the method in that direction. He had mentioned in the paper that wind caused trouble in the spraying of gasometers, but he suggested it was possible to construct a cabinet or a protector of a portable nature which would protect the operator while at work. Several spraying machines were on the market and were easily obtainable, their price depending on the size of the plant required. The two essentials controlling the suitability of the paint and varnish used in the apparatus were the specific gravity and the drying properties. Those firms which had made a special study of paints for use in spraying machines had produced excellent results. Over 700 firms making toys had started work in this country in the last twelve months, and there was not the slightest reason why they should not be successful. He recommended that paint-spraying should be adopted in that new industry, the under-coat consisting of a good water-paint and the top-coat of varnish.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Jennings for his interesting paper, and the meeting terminated.

ENGINEERING NOTES.

The Ljungstrom Turbo-Electric System.—The *Times*, in its engineering summary for the past year, dated the end of January, says use is made in this of the principle of the double-rotation, radial-flow turbine, and in experimental installations the system is stated to have given a demonstration of its suitability for marine machinery. This turbine is claimed to have a low steam-consumption in comparison with other forms, and to be well adapted for the employment of the high superheat with which certain troubles have been associated with some types of turbine. If, as is reported, contracts have been placed for the fitting of this system in several ships now building, some further data derived from actual service should be available at an early date. It is understood that Messrs. Beardmore have under construction at their works a Ljungstrom turbine, in which a mechanical drive will be employed.

Electric Railways in America.—The "James Forrest" lecture before the Institution of Civil Engineers was delivered recently by Mr. H. M. Hobart, and, among other information on the above subject, he drew attention to the continual decrease in the cost of manufacturing electricity as being both a consequence and a cause of the accelerated growth of the electric railway industry. He pointed out that twenty years ago it would have been impossible to manufacture electricity at a cost of much less than 2*d.* a kw. hour, and that ten years ago a price of 1*d.* a kw. hour would usually have been the minimum permitting of any profit. At present there are undertakings that could make a profit in supplying electricity to railways in their district at but little over ½*d.* a kw. hour; and, indeed, during the last two years many millions of units have been delivered on the premises of the Butte, Anaconda, and Pacific Railway at a price of 0·265*d.* Again, fifteen years ago the best generating sets, consisting of slow reciprocating engines direct coupled to dynamos, cost about £30,000 for a 3,000 kw. set, which was considered about as large as could be used to advantage; but now 30,000 kw. steam turbine sets are available at a price considerably below £60,000. Further, the 3,000 kw. set of fifteen years ago consumed some 18 lb. of steam per kw. hour, whereas the present 30,000 kw. set consumes only about 12 lb. The corresponding progress in steam-raising and condensing plant, in conjunction with the requirement of only about two-thirds as much steam and fuel, may be taken, roughly, as at least halving the initial outlay per rated kilowatt installed for these components of an electricity manufacturing plant. Developments in hydro-electric plants have also been very satisfactory, but in districts where coal is obtainable at a low price it is rarely possible for them to supply electricity at a competitive price except for applications with a fairly high load factor. Reference was made to the 11,000 volt lines of the Norfolk and Western Railway, electric operation of the Bluefield division of which was inaugurated in May last with twelve 240-ton locomotives of the split-phase type. This section is twenty-nine miles long, with double track except through the Elk Horn tunnel, in which eastbound trains ascend a gradient of 1·5 per cent. The journey from Vivian to the tunnel, a distance of about fifteen miles, with a rise of about 900 ft., is performed in about an hour with coal trains weighing 2,900 British tons, drawn by two 240-ton electric locomotives, one at the front and the other at the rear. Formerly, with a train of the same weight, three 240-ton Mallet locomotives were employed. The total weight of the trains was therefore 3,620 tons, as compared with 3,380 tons for electric operation, and the speed attained was only about seven miles an hour, exclusive of stoppages for coal and water. Mr. Hobart drew special attention to the elimination of congestion at tunnels. He stated that electric trains maintaining a speed of fourteen miles an hour can be dispatched through the Elk Horn tunnel at the rate of one every three minutes, against six miles an hour steam trains, of less useful weight, every seven minutes. Taking into account the greater useful tonnage of the electrical trains through the

tunnel and the higher speed, he thought it might fairly be stated that any bunching up of tonnage on the division can be relieved by electric operation in about one-third of the time required with steam locomotives.

Australian Transcontinental Railway.—This important connection will be 1,063 miles long, and will save the mails and passengers, which at present go by sea, two to three days in time, according to destination. The country passed through—Port Augusta, South Australia to Kalgoorlie, Western Australia—is fairly easy and bridge work light, but is practically a waterless desert, except for grazing purposes and what it may bring forth in the future as regards mineral wealth. Separate from the above, which we derive from various sources, Mr. W. C. Bell, the Chief Engineer of the Commonwealth Government Railways, reports, in the latest advices, that in Western Australia the route has been surveyed and definitely located for 260 miles. In South Australia the survey is complete throughout, and the route has been definitely fixed for the 428 miles 51 chains between the terminus of Port Augusta and Ooldea. Two hundred and forty miles in Western Australia and 263½ miles in South Australia were ready for platelaying, out of which total of 503½ miles 495½ miles had been done. Very heavy earthworks at the South Australia end are now being approached, but it is hoped that the rails will be laid throughout by the end of the present year.

Swedish Army Oxy-Acetylene Searchlight.—The American Illuminating Engineering Society describes the use in the Swedish army of a pellet of ceria in place of the lime of the oxy-hydrogen lantern, and an oxy-acetylene jet. The consumption is stated to be about 40 litres of acetylene and a like quantity of oxygen per hour, and sufficient supply of these gases to provide for twenty hours burning is carried with the apparatus. It is also stated that searchlights are being used, not only to detect the movement of the enemy, but to blind troops when charging, and to discomfort the pilots of aircraft. Owing to the blinding and confusing effect, it has been found to be impossible to advance troops in the face of strong searchlights, thus affording a practical illustration of the use and effect of glare. In this connection it is interesting to note that the importance of the problem of glaring motor headlights is also being recognised. A series of tests have been worked out which may be used as standard definition of what constitutes a dangerous "glare," and the results will be submitted to manufacturers of headlights with a view of eliminating the trouble. Future headlights are to be constructed according to scientific formulae, by which the far-reaching effect of a searchlight upon the road without glare will b obtained.

The Construction of the Largest Dry Dock in America.—The new South Boston dry dock is to be the largest in the country, being 1,200 ft. by 149 ft. in over-all dimensions. A wide variety of plant, including cableways, locomotive cranes, compressor plant for drills, mixing plants, a variety of floating plant, and, indeed, almost everything but steam shovels, will be used in carrying out the contract. A dredge is already at work on the site of the dock proper, the contractors are expected to bring up one of the biggest dredges on the Atlantic coast, which can handle 150,000 cubic yards of material per month, and which make short work of the 450,000 cubic yards to be dredged from the dock site proper and dumped at sea. Two large areas of land, between which lies the site of the dock and approach channel, have already been made by filling in between recently constructed bulkheads. The rest of this embankment will be made, after the dock is finished, from the material dragged out of the approach channel. This material will also be used to complete the embankment between the dock walls, after heavy bank of rip-rap to be excavated from the dock floor has been placed around the outside of the walls. About 85,000 cubic yards of rock must be excavated all over the dock floor. Considerable saving has been effected in the design by the plan of excavating beneath the walls only enough to secure a solid foundation, a sloping blanket of concrete joining the toe of each wall to the floor concrete of the dock. The contractors will spend the time until the dock site is dredged assembling plant. Then a cofferdam will be thrown across the lower end of the site as indicated, and the water pumped out. Active work on removing the rock will not start before the middle of the spring.

Pneumatic Process for Tamping Railway Sleepers.—Military and munition workers are scarce; therefore it behoves railway men to make use of machinery as much as possible. Compressed air has been used successfully for tamping sleepers on a part of the New York Central and Hudson River Railway. The tamping outfit consists of two pneumatic tampers, 600 ft. of 3-in. hose and an air-compressor mounted on a hand-car. The compressor is driven by a gasoline engine, which also propels the car itself at a speed of from twelve to fifteen miles per hour. The car will carry twelve men, and is equipped with cross trucks, with the aid of which four men can remove the car from the track in less than a minute. Each tamper is fitted with a tamping bar of the ordinary shape, and weighs, complete, 37½ lb. It is stated that the machine is equally effective for stone, gravel, or cinder ballast; that it can be worked to advantage around crossings and switches where hand tamping is difficult or impossible; and that maintenance men prefer it to the

tamping pick or tamping bar. The record showed that two men can average three hundred sleepers per day. A service test was made some time ago to determine the comparative stability of track tamped by hand and that tamped pneumatically. A section of track on the West Shore Railway in New Jersey was selected where the foundation is soft, and it is difficult to maintain the track in good condition. An 800 ft. stretch of track was tamped by machine and an equal length by hand. After six months' observation the machine tamping showed practically only half the settlement of the hand tamping.

Irrigation in the United States.—The total work of the United States Reclamation Service, completed up to the present fiscal year, according to a summation prepared by the service, includes 9.592 miles of canals and branches, the excavation of eighty-nine tunnels with an aggregate length of more than 25 miles, the building of 4,622 bridges with a total length of 19 miles, the construction of 82 miles of railway and the erection of 1,068 buildings, such as power-houses, pumping-stations, offices, residences, and store-houses. Dams of masonry, earth crib and rock embankments have been constructed, with a total volume of 12,200,000 cubic yards. The available reservoir capacity at the time of the summation was, approximately, 6,500,000 acre-feet, or sufficient to cover the States of New Jersey and Delaware to a depth of 12 in. Culverts built number 5,714, and total 36 miles in length. There are now in operation 298 miles of pipe line and 85 miles of flumes. Waggon roads have been built to an aggregate length of 784 miles, many of them in what were inaccessible mountain regions.

OBITUARY.

P. N. Muthuswami Naidu, B.A.—Mr. P. N. Muthuswami Naidu, of Madras, who was only elected a Fellow of the Society in November last, died on February 3rd. Mr. Muthuswami Naidu, who was for long in business at Madras, was one of the earliest graduates of the Madras University. In later life he took a prominent part in educational and other public movements in the Presidency. He was instrumental in establishing the local branch of the Y.M.I.A., and was a member of its managing committee. He was secretary of the South Indian Chamber of Commerce, and founded the Lakshmi Hindu Balika Patashala, a free school for girls at Saidapet. He had travelled in Europe, America, Japan, and China.

The Hon. Sir Chinubhoy Madavlal, Bt., C.I.E.—Sir Chinubhoy Madavlal, who had been a life member of the Society since 1900, died at Ahmedabad on March 2nd. Sir Chinubhoy's grandfather established the first spinning-mill in Ahmedabad, and he carried on the tradition of his family by taking a prominent part in the development of the textile industry in the Bombay Presidency. He was a member of the Legislative Council of the Governor of Bombay, and Chairman of the Ahmedabad Millowners' Association. He was the founder or supporter of many scientific and educational institutions in the Presidency, and enjoyed a very high reputation as a leading member of the mercantile community and as a philanthropist. His public services were recognised by his being made a C.I.E. in 1907, a knight in 1909, and a baronet in 1913. He was the first and, so far, the only Hindu to be created a baronet.

GENERAL NOTES.

Production of Zinc.—In his recent presidential address at the annual meeting of the Institute of Metals, Dr. G. T. Beilby urged that more attention should be paid to the industrial side of metallurgy. Before the war it was taken for granted by British users of zinc that there would always be an ample supply of this metal. It must have been an awakening to those optimists when the price of zinc ran up many times its normal value. He strongly urged that zinc-smelting should be established in Great Britain at the first opportunity. As to the German monopoly of metal-magnesium, there was no reason why this metal should not be produced on a large scale and at a comparatively low price.

Gypsum in Canada.—The gypsum industry is one of the most important and one of the oldest of the mining industries of Canada. In order of magnitude amongst the world's gypsum producers, Canada ranks third. The chief producing provinces are Nova Scotia, New Brunswick, Ontario, and Manitoba; but a small amount is also obtained in British Columbia. The output of these various provinces during 1913, according to the Annual Report on the Mineral Production of Canada for 1913, was as follows:—

	Tons.	Value in dollars.
Nova Scotia	404,801	479,515
New Brunswick	103,954	279,395
Ontario	62,315	208,029
Manitoba	65,100	479,500
British Columbia	200	1,300

The gypsum industry of Canada consists chiefly in quarrying the crude gypsum, and in shipping it in that condition to the United States, where it is calcined, and in part shipped back to Canada as a finished product.

Export of Dried Apples from the United States in War Time.—The influence of the war on the destination of shipments of dried apples from the United States to European ports has been very marked. During the five

fiscal years ending 1914, the average annual quantity of this description of fruit amounted to 35,137,000 lb., to the value of $2,815,000 (£563,000), as compared with a maximum of 53,665,000 lb. in 1912, and a minimum of 21,804,000 lb. in 1911. Since the outbreak of hostilities these figures have increased nearly 21 per cent. above the average of the five previous years, and amounted for the fiscal year 1914–15 to 42,589,000 lb., to the value of $3,271,000 (£654,200). The following shows the percentage of these exports shipped to the various European countries during the two periods—in order of their importance:—

	1909-14.		1914-15.	
Germany	47·7	per cent.	·25	per cent.
Holland	27·4	,,	12·20	,,
Belgium	5·5	,,	*Nil.*	
Denmark	3·7	,,	42·00	per cent.
Sweden	3·2	,,	25·40	,,
Norway	4·5	,,	·90	,,
Great Britain	3·4	,,	12·00	,,
Other countries	4·6	,,	7·25	,,
	100	,,	100	

From these figures it appears that, whilst the exports to Germany have declined from 47·7 per cent. to practically *nil*, those to the neutral countries of Denmark and Sweden have increased tenfold (from 6·9 to 67 per cent.). It would be interesting to know how much of this enormous increase finds its way ultimately to Germany.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

May 3.—Professor W. B. Bottomley, M.A., F.C.S., F.L.S., "Bacterised Peat."

May 10.—Sir Francis Taylor Piggott, M.A., LL.M., Chief Justice of Hong-Kong, 1905–1912, "Contraband and Blockade." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

May 17.—George Percival Baker, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe." Sir William Martin Conway, M.A., F.S.A., F.R.G.S., will preside.

May 24.—John Collett Moulden, A.R.S.M., M.Inst.M.M., "Zinc, its Production and Industrial Applications." (Peter Le Neve Foster Prize Essay.)

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

April 27.—James MacKenna, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

May 18.—Sardar Daljit Singh, C.S.I., "The Sikhs."

June 1.—Professor Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India." The Right Hon. Lord Islington, G.C.M.G., will preside.

Colonial Section.

Tuesday afternoons, at 4.30 p.m.:—

April 11.—Sir Daniel Morris, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Forest Resources of Newfoundland." The Right Hon. Sir William MacGregor, G.C.M.G., C.B., will preside.

May 2. — The Right Hon. Sir William MacGregor, G.C.M.G, C.B., LL.D., D.Sc., "Some Native Potentates and Colleagues."

Fothergill Lecture.

Monday afternoon, at 4.30 p.m.:—

Edward A. Reeves, F.R.A.S., F.R.G.S., Map Curator and Instructor in Surveying to the Royal Geographical Society, "Surveying, Past and Present." Three Lectures.

Syllabus.

Lecture III.—April 10.—*Modern Instruments and Methods of Geographical Surveying.* Advance made in recent years—Difficulties of obtaining accurate measurements—Circumstances that determine character of survey—Theodolites—Base line apparatus—Triangulation, with recent examples—Traverses with theodolite and tacheometer or subtense instruments — Plane-table, its use in topographical mapping, and recent improvements —Determination of heights—Photographic surveying—Astronomical observations for fixing positions.

The lecture will be illustrated with lantern-slides.

Cantor Lectures.

Monday afternoons, at 4.30 p.m.:—

J. Erskine-Murray, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

Syllabus.

Lecture I.—May 1.—*Periodic Motions.* Definitions and modes of production—Stable and unstable equilibrium — Inertia, gravity, and elasticity — Pendulums and spring oscillators of various kinds —Torsional vibrations, balance wheel—Corrugation of rails—Musical instruments—Complex vibrations and the quality of a tone—Vibrations on large scale, seismic tremors, vibrations of ships and buildings, lightning.

LECTURE II.—MAY 8.—*Waves in Ponderable Matter.* Transverse and longitudinal waves in solids and liquids — Methods of production and propagation — Polarisation — Wind waves — Ship waves—Tides and seiches—Cloud waves—Independence of wave trains—Superposition of harmonic motions—Sound waves—Submarine bells—Voice, phonograph, and gramophone.

LECTURE III.—MAY 15.—*Waves in the Ether.* Free and conducted—Light, heat, and electric waves — Alternating currents — Telephonic transmission—Wireless telegraphy—Submarine cables —Inductance, capacity, and resistance—Limits of known wave-lengths—Röntgen rays—Light—Heat —Reflection, refraction, and diffraction of wave motions—Stationary waves—Attenuation and distortion of travelling waves.

LECTURE IV.—MAY 22.—*Resonance.* Mechanical and electrical—Superposition of periodic impulses—Universal importance of the selective absorption of wave motions—Mechanical resonance or revibration — Screening of vibrations, absorption, and filtration — The acoustics of buildings — Sound resonators—Absorption of light waves—Coloured glass — Vision and photography — Absorption of electrical power by resonance—Tuning in telegraphy.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 10...ROYAL SOCIETY OF ARTS, John street, Adelphi, W.C., 4.30 p.m. (Fothergill Lecture.) Mr. E. A. Reeves, "Surveying: Past and Present." (Lecture III.)

Cold Storage and Ice Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m.

Brewing, Institute of (London Section), Imperial Hotel, Russell-square, W.C., 8 p.m. Dr. A. Fernbach, (*a*) "The Mechanism of Alcoholic Fermentation"; (*b*) "Some Observations on Malt Mills."

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Mr. W. R. Davidge, "Principles of Town-Planning."

Electrical Engineers, Institution of (Local Section), Mining Institute, Newcastle, 7.30 p.m. Mr. D. W. M. Thornton, "The Nature of Electrical Insulation."

TUESDAY, APRIL 11...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Sir D. Morris, "The Forest Resources of Newfoundland."

Electrical Engineers, Institution of (Scottish Section), 207, Bath-street, Glasgow, 8 p.m. Mr. D. M. Macleod, "Branches from E.H.T. Circuits."

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. Keeble, "Modern Horticulture. Lecture III.—Old and New Methods of Forcing."

Colonial Institute, Hotel Cecil, Strand, W.C., 8.30 p.m.

WEDNESDAY, APRIL 12...Naval Architects, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 11 a.m. 1. Address by the President. 2. Sir P. Watts, "On the Work of the Load Line Committee." 3. Mr. W. S. Abell, "Some Questions in Connection with the Work of the Load Line Committee."

3 p.m. 1. Mr. C. H. Lees, "The Laws of Skin Friction of a Fluid in Stream Line and in Turbulent Motion along a Solid of Great Length." 2. Mr. G. S. Baker, "Skin Friction Resistance of Ships and our Useful Knowledge of the Subject." 3. Professor T. B. Abell, "Experiments to Determine the Resistance of Bilge-Keels to Rolling." 4. Colonel G. Russo, "An Experimental Tank reproducing Wave Motion."

7.30 p.m. 1. Engineer-Lieutenant W. P. Sillince, "A Brief Summary of the Present Position of the Marine Diesel Engine and its Possibilities." 2. Mr. J. D. Young, "On the Co-ordination of Propeller Results." 3. Mr. T. C. Tobin, "Note on Maximum Propulsive Efficiency of Screw Propellers."

Electrical Engineers, Institution of (Yorkshire Section), Philosophical Hall, Leeds, 7 p.m. Mr. G. Wilkinson, "Electrical Heating: its present position and future development."

Automobile Engineers, Institution of, at the Surveyor's Institution, Great George-street, S.W., 8 p.m. Major B. W. Shilson, "From Engine to Axle."

Japan Society, 20, Hanover-square, W., 3 p.m. Dr. W. L. Hildburgh, "Some Japanese Minor Magical Practices connected with Travelling."

THURSDAY, APRIL 13...Naval Architects, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 11 a.m. 1. Sir A. Denny, "Sub-division of Merchant Vessels: Reports of the Bulkhead Committee, 1912-1915." 2. Mr. J. F. King, "Strength of Watertight Bulkheads." 3. Mr. A. T. Wall, "Some Effects of the Bulkhead Committee's Reports in Practice."

3 p.m. 1. Mr. J. Reid, "Notes from a Collision Case." 2. Mr. M. G. de Gelder, "Shipyard Cranes of the Rotterdam Dockyard Company."

Child Study Society, 90, Buckingham Palace-road, S.W., 6 p.m. 1. Dr. C. W. Kimmins, "An Account of Speed Tests of different kinds of Handwriting." 2. Mrs. Grainger, "An Experiment in Handwriting." 3. Miss Golds, "A New Method of Handwriting."

7.30 p.m. Annual Meeting.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. Hadow, "English Music in the Tudor Period. Lecture III.—Songs and Instrumental Pieces."

Optical Society, at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. S. D. Chalmers, "Practical Workshop and Laboratory Measurements." 2. Mr. T. F. Connolly, "Focometry."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Discussion on "The Present Position of Electricity Supply in the United Kingdom, and the Steps to be taken to Improve and Strengthen it."

Historical Society, 7, South-square, Gray's Inn, W.C., 5 p.m. Mr. G. P. Gooch, "Germany and the French Revolution."

FRIDAY, APRIL 14...Royal Institution, Albemarle-street, W., 5 p.m. Professor Sir J. J. Thomson, "The Genesis and Absorption of X-Rays."

Teacher's Registration Council, Caxton Hall, Westminster, S.W., 6.30 p.m. Address by the President of the Board of Education on "The Future Development of Education in relation to Science and Commerce."

Astronomical Society, Burlington House, W., 5 p.m.

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Mr. W. Clemence, "Theory and Practice in the Filtration of Water."

SATURDAY, APRIL 15...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Radiations from Atoms and Electrons." (Lecture VI.)

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FRIDAY, APRIL 14, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

COLONIAL SECTION.

Tuesday afternoon, April 11th, 4.30 p.m.; THE RIGHT HON. SIR WILLIAM MACGREGOR, G.C.M.G., C.B., LL.D., D.Sc., in the chair. A paper on "The Forest Resources of Newfoundland" was read by SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S.

The paper and discussion will be published in subsequent numbers of the *Journal*.

FOTHERGILL LECTURES.

On Monday afternoon, April 10th, 4.30 p.m., Mr. EDWARD A. REEVES, F.R.A.S., F.R.G.S., Map Curator and Instructor in Surveying to the Royal Geographical Society, delivered the third and final lecture of his course on "Surveying: Past and Present."

On the motion of the CHAIRMAN a vote of thanks was accorded to Mr. Reeves for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

JOURNAL.

The Government limitations on the importation of paper and paper-making materials have rendered it necessary to restrict the *Journal* to the smallest possible size. For the present, therefore, its contents will be confined as far as possible to a report of the actual proceedings of the Society, and it may be necessary occasionally to publish reports of the meetings a little less promptly than has always been the practice.

It is hoped that the Fellows will appreciate the necessity of such restrictions, and it is also hoped that the *Journal* may be able to expand to its normal size at an early date.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, March 28th, 1916; DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, in the chair.

The paper read was—

NEXT STEPS IN EMPIRE PARTNERSHIP.

By PERCY HURD,

Joint author with Mr. Archibald Hurd of "The New Empire Partnership: Defence, Commerce, Policy."

"We have arrived at the hour of our supreme trial and of our supreme opportunity." These words of Mr. Hughes, Prime Minister of the Commonwealth of Australia, may be taken as my text.

In our eagerness for wealth we have neglected security. Drifting complacently along the line of least resistance, with no particular care but our own ease, we have forgotten how that ease was won for us by our forefathers, and we have shut our eyes to the truth that eternal vigilance is the price of freedom. Thus we have come very near to the edge of the precipice—how near many of us do not yet realise.

"Never again," we are saying with united fervour, and "never again" is echoed back to us from every part of the Empire; but it is not words that are necessary, it is deeds—deeds of statesmanship worthy of the deeds of the men who are fighting for us, and for our children and theirs; deeds in pursuit of a high ideal.

And this is the ideal: To live under our own institutions, as free men, in home, nation, empire, and to ensure a like freedom for other peoples.

To overthrow this ideal of ours and establish a world dominion based upon force, Germany has organised a military and economic autocracy

of undreamt-of power and efficiency. To maintain our ideal we, too, must organise. Haphazard methods and drift will no longer do.

"A MERE DISORGANISATION."

Sir Robert Borden, the Prime Minister of Canada, has declared the British Empire to be "in some respects a mere disorganisation." One can fancy how heartily the professorial German would accept that definition. It is true, he would say, and therein lies the death sentence of England and England's Empire. He would argue the matter out with his usual precision. He would tell us that to be a "mere disorganisation" may have sufficed in former days and in former rivalries between such ill-devised Empires as that of our Elizabeth and Philip of Spain, and those of our early Georges and the Grand Monarque. But to-day—No. Kultur has arrived with its gospel of highly-developed and centralised organisation and untiring efficiency. Kultur as exemplified in the German Empire has met at every point the seemingly ill-organised and disjointed thing which we call the British Empire, but which is no Empire on any known model of the past—and Kultur must prevail.

We know that the German professors are hopelessly wrong in their diagnosis and their prophecy; but we are bound to admit, and we do well to profit by the admission, that the triumphs of Kultur as a purely material force have been many and striking. Had the strategic instinct of Prussia been guided by spiritual insight, ruin would not now be staring Germany in the face, and we of the British Empire should not be taking a new lease of life as we now are.

Take the sphere of applied science as an illustration. What tribute to the efficiency which is one of the products of German Kultur could be more arresting than the frantic efforts we have been making to undo in nineteen months of war the mischief of a complacent dependence upon Germany for essentials of our national and Imperial life? Too lazy or pre-occupied to attend to our own vital business and develop our own magnificent heritage, we found ourselves in the opening stages of the conflict labouring under a handicap which, had the German permeation gone on unchecked for another ten years, must have landed us in the gravest difficulties if not disaster.

For want of German dyes our great textile and other industries were brought near to a standstill; it was German carbons and magnetos which fed and ran our naval searchlights; deprived of optical glass, which we had allowed enemy countries to monopolise, many of our gallant soldiers have had to go into battle ill-equipped; and it was upon German chemicals and drugs that our medical services had come to depend for the purposes both of peace and war.

Contrast our land problem with that of Germany. Only under stress of war and the peril of our dependence upon imported food are we beginning to remember that British official statistics class as "farm lands" 3¾ million acres euphemistically declared to be "under grass," but producing little or nothing in the way of food for man or beast. The scientific methods of Kultur have turned similarly poor German lands into thousands of smiling homesteads. Apply the methods of Germany and Holland not only to these 3¾ million acres, but to the 12 million other acres of British heath and other so-called "waste" land, and you would make this country far more self-supporting, prosperous and happy, a far fitter nursery of our race.

The abundant metals of our own Empire, which we left unheeded, have become in the hands of German Kultur the means of sending to their death thousands of the flower of the youth of British countries. It is with the help of their own Australian spelter ores that German and Austrian armies have killed and maimed Australian boys in Gallipoli; the nickel and hematite ores of Canada have made their contribution to the murderous power of Krupp's among the Canadian troops in Flanders; and the wolfram resources of India have been used to overthrow the cause for which India has poured out her young life and wealth. It is the work of Kultur that has brought it to pass that, as the Solicitor-General confessed in the Admiralty Prize Court last September, the German octopus had before the outbreak of war thrown out its tentacles so successfully that the base metals of the world, and especially of the British Empire, were at the mercy of three great and highly-organised German concerns of Frankfurt and Halberstadt; and it is to Kultur expressed in a hundred other ways that Germany owes at this moment the astounding, even if infamous, war machine and the industrial and political organisation which have put Austria, Turkey and Bulgaria under her domination and are maintaining her stupendous fight against the world's three most powerful Empires.

Can you wonder that Kultur, which has accomplished so much on its material side, and which two years ago seemed so certain of win-

ning all it wished by the sheer force of efficiency and the quiet work of permeation—can you wonder that the disciples of German Kultur should have spurned the right of England to rule one-fourth of the world's surface by means which to the methodised German brain seems so planless and illogical ?

AND YET——

Let me put the case to you as it strikes the impartial and detached American. I quote from that influential American journal, the *St. Louis Republic.* It says—

"Whenever Germany and France, with their highly centralised and logically wrought-out Governments, have contemplated the fabric known as the British Empire they have smiled smiles of disdain. If ever there was an instance of 'muddling along' through decades, and even centuries, taking things for granted, avoiding issues, extemporising expedients, and working always for the object immediately in view, with scant reference to any principle of outward consistency, it is supplied by the history of the making of the British Empire. This is a strange gathering together of Crown Colonies, Dominions, Protectorates, a Commonwealth, Dependencies, and India. India is directly ruled by the Crown. Jersey, Guernsey, and Isle of Man are governed under their own laws, but certain officials are appointed by the Crown. Canada and Australia are both self-governing, but the Senators in Canada are appointed by the Governor-General, while those of Australia are elected. There is a Secretary of State for India in the King's Cabinet. And all gradations of self-government may be found in the more than ninety units of the British Empire.

"This fearful and wonderful fabric has no central body. There is no 'Bundesrath,' or Imperial Council. No collective action of its units is possible. The relation to them of the Mother Country is illogical, ill-defined. To the foreigners accustomed to the federation of the American States or of the units of the German Empire the Government looks planless and ineffective.

"All of which," adds our American critic, "is preliminary to the observation that there is not at the present moment any more effective institution in the whole world of political fabrics than the British Empire. Whatever its machinery lacks appears to be supplied by its spirit. The defects of its body are made up for by the unity of its soul. The fact cannot be gainsaid that England, who does not begin to be as logical as Germany or as systematic as France in matters of government, has, nevertheless, the knack of making men step out of their own free will to die in her defence. She has the gift of keeping alive, across tumbling seas, round half a world, the undying bond that unites the heart to home. She has shown herself indifferent to the possession of the taxing power over her Colonies—but what matters it ? Those Colonies willingly tax themselves to send her warships, and their sons seize their rifles in time of strife to go to her aid. She has the wisdom so to train and guide the swarthy children of alien races, and even the foes of yesteryear, that they put their living bodies between England and England's enemies. She has a fearfully muddled theory of government, but her practice of government lays hold on the deepest thing in the soul of men."

To that I would make this addendum in the words of an experienced Empire administrator, Sir Charles Lucas—

"The Empire, which is not a machine-made conquest but a growth, sown in all sorts of odd ways, and nourished by all sorts of odd sentiments and reasons, does not crush out life or stifle freedom, but increases life and enlarges freedom. Whatever his race or creed, a man in distant lands may be more, and not less, himself because he is a British subject."

OUR PROBLEM.

In these two passages lies my keynote, and the problem I wish to set before you is how this strange creation, the British Empire, this so-called "disorganisation," this seeming chaos which is no chaos, these ninety units in all manner of stages of self-government—Dominions, Crown Colonies, Protectorates and Dependencies—how we are to find the means of perpetuating their unity and how we are to carry into every sphere of the political, social and commercial life of these scattered and diverse communities the oneness of purpose and ideal for which the men and women of the British family in all the four quarters of the world have been willing to sacrifice their all during the past terrible nineteen months.

For that is my starting-point—the British Empire has to-day arrived at the stage of partnership. And—for us most significant and momentous fact of all—it is a partnership in the cause of freedom. You do not start with a clean sheet upon which to map out the future of the Empire and fashion some beautiful Empire fabric which shall burst upon the world at some dramatic and glorious moment. The fabric is being quietly fashioned from day to day under the pressure of necessity and common interests, and it is only by taking full account of what is happening before our eyes, if we will but see it, that we can hope to make our influence felt.

We have been so engrossed in the business of fighting that most of us have perhaps overlooked

the lengths to which this partnership of the British Empire has already gone. I lay stress upon this present partnership because it is ever the way of British progress to let what shall be follow as naturally as may be from what is; to adapt rather than to reconstruct; to make the future an ordered sequel to the present and the past.

While British Ministers Hesitated.

First there springs to the mind the partnership of fighting men, the comradeship of the battlefield, the battleship, the hospital, and, let me add, the desolated home. It has been one of the glorious aspects of a war that has been in some ways so inglorious, and it has been one of the chief props of our minds in this time of stress. For our encouragement along the paths into which the partnership of Empire may lead us if we have but the faith of our forefathers, I beg you to note the spirit and quick decision with which the Dominions ranged themselves by England's side when the hour for action had struck. In the fateful closing days of July and opening days of August, 1914, our own Ministers stood trembling upon the brink. To Germany they said that we must not be thought to be out of the pending conflict; France, our desperately anxious ally, they told that we must not be thought to be in it. The incident recalls the phrase of Caroline in a London play of the moment. She is troubled by the fact that she does not know her own mind. "Don't let that worry you," she is told. "The British Empire is governed exclusively by gentlemen who suffer from the same complaint."

However, it is no part of my business to attempt to criticise this halting of British Ministers between two opinions—the historian must do that upon far fuller information than we now have; but I am concerned to seek comfort in the fact that there were no hesitations among our partners overseas. They saw at once that liberty was at stake, nothing less—their own liberty and the world's liberty. While the British Cabinet inclined first one way and then another, urgent telegrams were reaching Downing Street from the Ministers of the Dominions, pressing for guidance that they might throw their whole weight into the scale in the most acceptable way; and before the German and Austrian official mind had abandoned the expectation that Canada and other British Dominions would remain neutral, if indeed they did not welcome deliverance from the so-called British yoke, fully-equipped Dominion forces were actually crossing the seas to come to our support, and New Zealand and Australian battleships were taking their place in the British battle line.

Anzac and Langemarck have since been added to the imperishable roll of the heroism of our race. General Botha and General Smuts were our indomitable foes a few years ago; we see where they stand to-day. Our Empire has not been spared its rebellions in our modern history; the sons of the former rebels are now among the staunchest of the men in khaki. Among these rebellions were the Papineau rising in Quebec and Riel rising in the North-West. A Papineau is now in hospital after fighting valiantly in the Canadian Expeditionary Force in Flanders, and it was only last month that a soldier's death claimed Sniper Riel of the Winnipeg Rifles, but not before he had himself placed twenty-nine Germans to his credit.

It is to such things as these that our children will point when they seek proof of the inherent rightness of the British way of Empire, and let us especially remember that these men, having faced death for liberty and British institutions, are the men who in every corner of the King's Dominions here and overseas will have a preponderating voice in the fashioning of our future. Empire partnership, we may be sure, will have quite a new meaning for them. Hitherto Empire has meant for a great part of the peoples of the Empire little more than after-dinner oratory and the occasional waving of flags. To the man of the Canadian prairies, or the Australian sheep farmer, the Empire must henceforth mean far more than a mere question of the King's effigy upon a postage stamp or a signature at the bottom of a writ. It is a possession and trust for which his son has fought and maybe died—a trust to which he dare not be false, and which he will not allow his leaders to neglect.

The Armies of the Empire.

A British Member of Parliament, seeking the other day to point the moral of this co-operation on the fields of battle, forecast a centralisation of the armies of the Empire under the supreme control of Whitehall. I know of nothing less likely. It would run directly counter to the great body of Dominion sentiment and practice as evolved during the past two decades and accentuated by the experience of the present war. The example of Australia will, I hope and believe, be followed in other parts of the Empire and by means of the cadet system and national

military system the whole of the youth of each nation will be trained to defend their country. Australia has, I hope, taught us that this strengthening of the defensive power and physical and moral character of the nation can be secured with no danger of an excessive militarism. But there will continue to be not one but several armies raised and trained in each section of the Empire, each reflecting the aspirations and social conditions of its own community.

Our next step in Empire land defence policy is, I believe, quite different—namely, a far closer co-ordination of system and method in ways which the present war is proving to be most effective, a much greater intimacy for staff and administrative purposes and a more adequate and continuous representation of Dominion opinion upon the Imperial Committee of Defence. General Smuts has taken the place of General Smith-Dorrien in command of a British force. It would be good news that a similarly high command had been given to some of the Canadian and Australian officers who have proved their high quality in combat, and to us who look on as laymen it may seem that the time has come to take fuller and more direct advantage of their experience and power of initiative in the general direction of British operations in the field. The seeds of a closer co-operation in future years have already been sown. In the Imperial General Staff there reside great possibilities. There is no need for a rigid standardisation. Each Dominion must continue to be a law unto itself in military matters; but the more the Imperial General Staff becomes really Imperial, and is linked with General Staffs in the Dominions, the more effective will be the co-operation of our armies in the field as a compact force, reflecting the spirit of the race and losing nothing by reason of its wide distribution.

The Navy.

The evolution of the naval policy of the Empire may very well take a different line. As seen from the British standpoint, the obvious moral of the war would seem to be that the little navy, like the little nation, is likely to fare ill under modern conditions. Admiral Cradock's fleet went down before the superior force of Von Spee, and Von Spee had to submit to the same fate when he encountered the ships of Admiral Sturdee. We take pride in the fighting pluck of the Australian Navy, but, as Mr. Hughes said the other day, " there was only one 'Emden.' " The security of the ocean highway has been maintained because the Great Fleet has effectively prevented the emergence of enemy ships from Kiel Harbour. General Botha drew the right moral when he declared, after his land victory: " Were it not that the British Navy kept the seas clear, it would have been absolutely impossible for us to achieve what we have done."

This example suggests the key to our future naval policy. No conceivable Canadian Fleet in North American waters, and no Australian Fleet in the waters of the far Pacific, would have saved Canada or Australia in August, 1914. Their fate was decided in the North Sea by the mobilisation of the Grand Fleet under Admiral Jellicoe thirty hours before war was actually declared. In another crisis it may be in the Mediterranean, the Pacific or the Atlantic that the fate of the Empire will be put to the test; but wherever it is, there must also be the immediate striking force which gives the Empire its mastery of the seas. If we in England read the naval lesson of the war aright, there must be not several navies, but one navy for securing instantly and on the very first threat of war those conditions at sea without which the Empire cannot exist and cannot use its armies. That is the basic naval principle—unity for concentration at the point of danger before danger actually exists. In these Empire matters there is no question of compulsion—the controlling force is reason, sympathy and good fellowship in a great cause. It is a matter for each Dominion to say how far it accepts the principle of naval unity, and how far it desires to act upon it. There would, of course, remain full scope for the development of the local naval resources of each Dominion, and there is also, as it seems to me, everything to be said for Mr. Churchill's proposal of an Imperial Squadron made up of ships of each section of the Empire and representing the Empire successively in every sea. It would also be most natural to constitute a representative Imperial Navy Board visiting the Dominions as circumstances might suggest, showing the flag in the outer seas, and working in close association with the Board of Admiralty and the Naval War Staff for the common naval purposes of the Empire.

Air Supremacy.

But this war has developed a new menace to our security—the menace of the Zeppelin, the aeroplane and the seaplane; and to the supremacy of the sea we must now add the supremacy of the air. It is surely significant of the adaptability

and unity of purpose of the peoples of the Empire that some of the most intrepid of the airmen now wearing the King's uniform are boys from Toronto and Winnipeg. Many of our aeroplanes are gifts from overseas communities, and a recent message from Australia told us that the Commonwealth had decided to send a flying squadron to the front from Australia.

There are those who dream that this war will be the end of all wars. History does not, alas! point that way, nor does the fact that the greatest of neutrals, guided by the chief of her pacifists, Mr. Woodrow Wilson, is preparing a five-year programme for the creation of a navy equal to that we possessed before the war, and an army costing 36 millions sterling a year. And as for ourselves, we shall probably have to repeat what the Imperialist Cromwell said to his Parliament in 1649, when he declared: "You have accounted yourselves happy in being environed with a great ditch from all the world beside. Truly you will not be able to keep your ditch, nor your shipping, unless you fight to defend yourselves. If you shall think this is a time of sleep and ease and rest . . . I have this comfort to Godward: I have told you of it."

Overseas Industrialism and the War.

I pass from the partnership of men of war to the partnership in materials of war, and here I touch upon an aspect of the conflict which must profoundly affect our future policy. We have hitherto thought of the Dominions as primitive countries, wide spaces from the used fragments of which come the wheat, meat, wool, timber and metals of our daily needs—foodstuffs and raw materials—which they have exchanged for the manufactures of this and other countries.

But see what nineteen months of war have done. Take the case of Canada. Before the war not a single shrapnel shell was made there, and in the whole Dominion only one small factory was turning out war material of any kind. To-day there are factories in every province from Atlantic to Pacific, engaged night and day for the war needs of the Allies. The results of the driving power that has brought Canada to her present place as an industrial war force are almost beyond belief. Major-General Sir Sam Hughes, the Canadian Minister of Militia, told the House of Commons at Ottawa on January 25th, that already Canadian factories had turned out 22,000,000 shells, which required in manufacture over 800,000,000. lb. of steel, 45,000,000 lb. of brass, 22,000,000 lb. of copper. and 10,000,000 lb. of cordite. An army of 90,000 skilled mechanics had been trained in industrial work, in addition to the army of 250,000 trained for fighting. More than 1,100,000 shells per month are now being shipped to Great Britain, and the cash value of the orders, representing new wealth to Canada, already totalled over $350,000,000.

You have only to go to one of the fortnightly gatherings of the Canadian Exporters Lunch Club here in London to realise the impetus given to the iron and steel and other industries of Canada by these special war activities. In addition, there have been established lead, cordite, zinc, brass and copper industries in various parts of Canada, which will furnish employment hereafter for at least 30,000 more skilled workmen. Thus it comes about, as the Minister said, that Canada is now in a position to furnish zinc to Great Britain and Russia at 15 cents per lb., as compared with 42 cents per lb. charged by the United States. Yet only a few months ago every bit of Canadian zinc was secured from the United States. Canada supplies 85 per cent. of the nickel of the world, the nickel production which no longer depends upon naval armament or martial requirements. Nickel steel in various forms is used in a wide range of industrial operations, as well as in the manufacture of ordnance and projectiles. Large quantities of plate were used in connection with the reconstruction of the Quebec Bridge, and nickel has entered into all sorts of railway materials, marine engines and propeller shafts, and a thousand and one lines of the manufacturing trades. Hitherto these Canadian nickel ores have been refined in the United States and this country. Under the encouragement of the Canadian Government, the International Nickel Company of New Jersey is now establishing a refining plant in Canada.

Some of the best of the British submarines were built on the banks of the St. Lawrence, and many millions of pounds' worth of war orders have been placed in Canada on behalf of the Allies for textiles and woollens, boots and shoes, harness and saddlery, rifles and ammunition and hardware, to say nothing of tinned meats, canned foods and other manufactured products. Indeed, we have it on the authority of the Hon. J. D. Hazen, Canada's Minister of Marine, that, on account of the Imperial Government alone, shipping from Canada has to be provided for 125,000 gross tons of munitions

and war supplies per month, or approximately 1½ million tons per annum. And this from a country which eighteen months ago was classed as mainly agricultural and primitive.

The comparative remoteness of other Dominions has left them less influenced as yet by this new wave of industrialism; but the situation that has developed in relation to the spelter ores of Australia is full of meaning and of warning. Only now, in the midst of a struggle for all that we hold dear in life, do we realise that it is not our war machine, but the war machine of our enemy that has derived the chief benefit from the illimitable metal resources of many parts of the Empire.

Before the war Australia fed Krupp's and other German enemies to the extent of £3,500,000 worth of lead and zinc ores, crude copper, tin and lead annually; Britain, the Mother Country of Australia, took a second place. Indeed, the German agencies which controlled Australian metal for the benefit of Germany's war machine were situated here in London, and carried on their work under the protection of British laws. After not a little difficulty with British Ministers and British law officers, this German control of Australian metal resources is being ended. That it should ever have existed constitutes, as has been said, "the gravest reflection upon British enterprise, capacity and common sense." Australia is taking the necessary steps to "cut every German fibre out of her industrial life." She is also, in the phrase of Mr. Hughes, "learning lessons in economy of labour that will remain a permanent possession." Instead of exporting her metallic ores to Europe, as she did before the war, her lead she is treating in Australia itself, and 90 per cent. of her copper output is being turned into copper goods on the spot.

This is what Canada and Australia are doing to strengthen their industrialism, and, learning from the bitter experience of this war, the imperative duty is now laid upon us all to apply our legislation, our administration, and our business faculties to the great work of developing the resources of every part of the Empire, not in the interests of our proven enemy and the enemy of liberty and civilisation, but in the interests of the Dominions and the Empire as a whole, and our proven friends among the nations. We shall be false to the trust placed in our hands if we neglect this insistent duty, and if we perpetuate the criminal folly of building up our industries upon a foundation controlled by the enemy.

A more Self-supporting Empire.

Amid the preoccupations of war the British public has little realised the extent to which the self-governing British peoples overseas have thrown their all upon our side in the present struggle. Although independent in fiscal matters, and completely in control of their own trade, the Dominions have from the outset of the war adopted every device to give England and the Allies the sole benefit of their production. In one issue alone of the *Board of Trade Journal* 130 pages are occupied with the export prohibitions of British Dominions, Dependencies and Protectorates, and their general purpose is to bring to our aid the full advantage of overseas food products such as wheat, meat, sugar and dairy produce; raw materials such as wool, leather and metals; and manufactured goods such as metal-working machinery and various textiles.

In this spontaneous and far-reaching co-operation we see the partnership of Empire in actual operation. In it we may also find an irresistible argument for increasing a commercial association which is immune from political entanglements and the rival interests of neutral, even if friendly, States, and by means of which even under stress of war the power of the Empire is immeasurably strengthened. In the full war year of 1915 the overseas Empire contributed 272 million pounds' worth of food and raw materials to the side of the Allies. Despite all the impediments of war and such embarrassments to overseas production as the curtailment of banking facilities, the cessation of borrowings for railway and other extensions of settlement, and despite the mobilisation of men and industry for the war purposes of ourselves and the Allies—despite all these war conditions and allowing for increased prices, we see that the British Dominions and Possessions have together been able to sell in the United Kingdom considerably more of their produce than in the record year of peace, 1913. There is no need of British homes and factories which our own Empire cannot provide, and with mutual forethought and organisation very much of the 370 millions pounds' worth of foodstuffs and materials of industry which we bought in 1915 from foreign lands can be obtained from within our own territory. The British Empire should be made far more self-supporting than it now is, and in making it so we have the comforting assurance that by buying more largely from within the Empire we are adding to the stability, progress and purchasing power of those who are our

comrades in the tasks of Empire and our best customers for British manufactured exports.

The Dominions Royal Commission.

What, then, are the next steps of Empire partnership in respect of trade ?

A first and urgently necessary step is to take stock of these Empire resources. There has been in existence for four years a Dominions Royal Commission, representative of the United Kingdom and the Dominions. It has done useful work, but we turn to its reports in vain for the facts as to the German control of Empire metal resources and the means of its eradication. Neither the Commission itself nor the Ministers who appointed it seem to have taken its task very seriously. Instead of finding in the war a fresh incentive, the Commission blandly informed the world in December, 1914, that it had "decided to suspend its sittings until the conclusion of peace." We shall be deaf indeed to the moral of our present difficulties if the Commission or some better-equipped body is not immediately set to work to prepare the way for a far-reaching policy of co-operation in developing our unmatched resources for the benefit of our own peoples.

Had we had an Imperial Development Commission representative of the whole Empire working under a vigorously minded Imperial Minister of Cabinet rank, and in cordial co-operation with the Development or Conservation Commissions of England, Ireland, Canada, and other parts of the Empire, we should not to-day be lamenting the scandal of British and Dominion resources neglected or allowed to pass under control of the enemy. Take an illustration from India to which attention is called in to-day's *Times*. It could be amplified from almost any part of the Empire. A single small district of Burma is capable of supplying more than half the world's annual requirements of tungsten—the tungsten whose self-hardening properties are needed for the making of machine tools, heavy guns, and armour-plate. Yet before the war we left this essential material to be developed by Germany; German interests controlled the whole output of the industry. A vigorous new Lieutenant-Governor, Sir Harcourt Butler, has now given an entirely new aspect to the business. He has cut out the German cancer, the German interlopers have vanished, and the *Times* tells us that this British district hums with British and native life.

Administrative and Fiscal Preferences.

The administrative preference which has been one of the most welcome features of the British management of this war should be continued and extended. A very few years ago it was impossible to get the Admiralty to look at coal and timber and meat from the Dominions; they were newcomers, and it was just habit rather than malice which shut them out from tenders for the British Navy in favour of the corresponding products of foreign lands. The comradeship of Canada, Australia and New Zealand upon the battlefields of Flanders and Gallipoli has jerked the departments out of their old cosmopolitan grooves, and reminded them that Empire products are *our* products, while foreign products are not. It must be our business to keep them jerked out. Quality and price being duly considered—New South Wales, I see, is allowing a 10 per cent. differentiation in favour of British over foreign products in its purchases of supplies—it should be the business of Empire Governments, municipal bodies and business houses and private citizens to see that their choice is for Empire over foreign goods. We are thus helping our friends and weakening our enemies, and building new barriers of defence for the principles of civilisation which we live to uphold and promulgate.

Mr. Runciman has set an example and made a beginning in his embargo policy. Finding it essential to secure, for the necessaries of life and war, tonnage space now occupied by goods which in this time of stress may be regarded as less necessary, the President of the Board of Trade is seeking to curtail the importation of bulky goods such as paper and paper-making materials, fruits, tobacco, furniture woods and so on. Many difficulties lie in the way, but it is at least satisfactory that in recognition of the family idea in trade the fruits of Australia, Canada and South Africa are exempted from this shipping embargo. We should see to it that the same principle is applied to the wood pulp of Canada, the paper of Newfoundland, the woods of Australia, and every other commodity with which the embargo policy deals.

In a few weeks' time the British House of Commons will have an opportunity of encouraging Ministers to carry the same principle into the sphere of finance. Mr. McKenna may have to raise another 100 millions sterling from taxation, and if necessity leads to an enlarged British import tariff, we should be spared a repetition of the unfortunate precedent of the Budget of 1915, when dutiable imports from the

Dominions were made liable to the same taxation as those from foreign lands. This is not how Canada, Australia, New Zealand and South Africa treat British goods, and now that the conditions of war and British revenue necessities have compelled a change in our fiscal system, we can no longer afford to reject the repeated demand of all the Ministries of the Dominions as made at each successive Imperial Conference since 1902. That repeated demand is that the Motherland should do as the Dominions do and recognise the Empire family through the medium of "preferential treatment to the products and manufactures of the Colonies, either by exemption from or reduction of duties now or hereafter imposed." May we also hope that in his forthcoming Budget, with its probable increase of income tax, Mr. McKenna will recognise the injustice and folly of duplication of taxation on the same income within the Empire. This is not the time to drive British capital into foreign lands.

The Cabinet.

In the sphere of policy as in defence and commerce the trail of Empire progress is being blazed for us by war conditions. The Imperial Committee of Defence, which we owe to Mr. Balfour's initiative, has been more than justified in the fierce testing time of this war, and when the war is over it must become far more expressive of the power of initiative and efficiency which the armed forces of the Dominions are now known to possess. The Imperial Committee of Defence with its Dominion members grew out of the Imperial Conference; so the exigencies of the war relationship of the States of the Empire are evolving a new means of intimacy through the medium of the Cabinet. On July 14th, 1915, Sir Robert Borden attended a meeting of the British Cabinet upon the invitation of Mr. Asquith; during his recent visit to Ottawa, Mr. Hughes, the Prime Minister of the Commonwealth, was sworn in as a member of the Canadian Privy Council and attended the Canadian Cabinet at Ottawa; and this month, again upon the invitation of Mr. Asquith, Mr. Hughes attended the British Cabinet. Unknown though it is to the constitution, the Cabinet is the supreme executive power in the British State, and it is through this agency of the "King in Council," that is to say, the Committee chosen by the Prime Minister and called the Cabinet, that the sovereign power is exercised. The House of Commons has been told by British Ministers that this entrance of Dominion statesmen into the inner chamber of the Imperial executive is not to be regarded as "an isolated incident, but as carrying out the general trend of policy which is proceeding further in the same direction."

Who can say how far this development may lead us? This first step, taken so quietly, has been heralded as revolutionising the theory and practice of the system by which this country has been governed for more than a century and a half, but it is obviously illogical and incomplete. As I have endeavoured to explain in detail elsewhere, the British Cabinet is, so to speak, a Standing Committee of the British Houses of Parliament, and its authority rests upon its responsibility to the British Parliament, and through that Parliament to the British people. Dominion Ministers may sit as occasion demands in the British Cabinet, but they cannot share the responsibility of British Ministers to the British Parliament and peoples; it is to the Parliaments and peoples of their own Dominions that Dominion Ministers are solely answerable. Why not, some ask, an Imperial Parliament representative of the whole Empire? Such a Parliament would require a central Imperial Exchequer — it would require much else. Whether it will come in the future years no man can say. Who, indeed, would set limits to our future co-operation? But whatever be the ultimate constitutional relations of the States of the Empire we may be sure that they will grow out of existing conditions and immediate needs; and when any actual scheme for an Imperial Parliament and a centralised Imperial Executive in Downing Street is tabled and examined from the point of view both of this country and the Dominions, it does not seem to me that it is likely to deal satisfactorily with the infinitely subtle and varied relations, the constitutional, economic, and political elements, which make up the British Empire at the present time. That Empire is a growth rather than a creation out of hand, and a growth it is likely to remain.

What we have to face is that, as Sir Robert Borden has said, "we are moving away from the day when the foreign relations of the Dominions as parts of the Empire can be left to be determined in a species of trust by which the statesmen of the Mother Country, perhaps more or less in consultation with us, can settle these policies"; and we may say with the Canadian Prime Minister, that "those whom these questions concern must always reckon with the inborn feeling in the Canadian breast

that a British subject living in this Dominion must ultimately have as potent a voice in the government and the guidance of this world-wide Empire as the British subject living in the United Kingdom. Whether our home is in the British Islands or in Canada, we must be equals before the King. The full privileges, as well as the full duties and responsibilities, of citizenship are the right of the Canadian people," and let us add, of the peoples of all the self-governing Dominions.

The Heart of the Problem.

Mr. Samuel, a member of the British Cabinet, said the other day that "the Mother Country is very ready to admit the Dominions into a share in decisions of policy as soon as they desire such admission." It may be accepted as a step forward that the Prime Ministers of the Dominions are now made privy to the inner councils of the British Government, and, if the Ottawa precedent is followed, to the inner councils also of the Governments of other Dominions. At the Imperial Conference of 1911 Mr. Asquith flatly refused to contemplate any sharing by the Dominions in the authority of the Government of the United Kingdom in such grave matters as the conduct of foreign policy, the conclusion of treaties and all relations with foreign Powers. That is now dead history, and it is Mr. Asquith who has made it so.

What, then, is the next step? How are we to meet the demand of the Dominions to be given a larger share in the guidance of Imperial affairs? My suggestion is—keep your eye upon the Cabinet and the development of the Cabinet principle, here and in each self-governing part of the Empire, rather than upon any of the proposals we have had for an Imperial Parliament or an Imperial Senate. The Cabinet of each part of the Empire is of course amenable to the Parliament of that part of the Empire, but it is not Parliament but the Cabinet which settles the matters upon which the Dominions wish to have their say. We have a Cabinet in Downing Street which, under war conditions, has become non-party in character, and includes Dominion as well as British members; we have also a committee of the Cabinet, the Imperial Committee of Defence, in which British and Dominion Ministers together consider questions of defence, and at times foreign policy—as, for instance, the Anglo-Japanese Treaty. Through this dual agency—the Cabinet and its adjunct the Imperial Committee of Defence—the States of the Empire have found a means of co-operating both in council and in executive action without impinging upon the control of its own affairs by each State within the Empire. New spheres of co-operation are now being opened up—the mutual development of Empire resources and inter-Imperial trade, partnership in relations with our Allies and the enemy, and so on. Surely the time has come when these new inter-Imperial affairs should be lifted out of party conflicts as defence and foreign policy have been. The way will then be clear for an extension of the methods of intimacy in executive council which we have found to work well in the sphere of defence. If the Dominions desire to make their High Commissioners members of the Dominion Cabinets as Sir George Perley is a member of the Canadian Cabinet, they might, as members also of the British Cabinet, maintain the needed executive link in the absence of the Dominion Prime Ministers. It would be easy to criticise any such arrangement, but it might serve our present purpose, resting as it would do upon a basis of goodwill, mutual respect and understanding.

Our New Relations.

The new intimacy in executive council will soon be put to new tests. Partners in war, the Dominions are also to be partners in the negotiation of terms of peace. Concessions of vital interest to the Dominions will no longer be made behind their backs. I think especially of the conquered German Colonies in South-West Africa and in the Australasian sphere of influence.

In other directions the old order has passed away. On January 10th the British House of Commons unanimously adopted the following resolution upon the motion of Mr. Hewins:—

"That, with a view to increasing the power of the Allies in the prosecution of the war, His Majesty's Government should enter into immediate consultation with the Governments of the Dominions in order, with their aid, to bring the whole economic strength of the Empire into co-operation with our Allies in a policy directed against the enemy."

That resolution will, I believe, become historic, for it has been the herald of the Conference of the Allied Governments, which is now about to meet in Paris, and at which we may expect the foundations will be laid of the new economic relationship of the chief States of the world. For the first time in our history we accept as the basis of our policy, and accept

with the general assent of Parliament, the economic solidarity of the British Empire. In treaties, in tariffs, in trade, and in finance we have in the past spoken with many voices and have often worked at cross-purposes. In future we mean to speak with one voice to the outside world—to our Allies, to friendly neutrals and to the enemy who is no longer to be allowed to use the goodwill of other nations as a means of plotting for their overthrow and enslavement.

This new Empire solidarity must find expression in many directions. The treaty system of the Empire based upon the most-favoured-nation clause had been proved before the war to be entirely inapplicable to the national status of the younger Britains overseas. It was already in the melting-pot. In the new order the Dominions must stand as fully-accredited partners in all treaty negotiations with foreign States, and it will be strange if the States of the Empire, negotiating thus together with other Powers, do not wield a far greater influence than would be theirs in any such separation of interests as we were drifting towards before the war. Our diplomatic and consular services, like our treaty system, must be made to correspond with the new Empire conditions. The navigation laws of the Empire, our dangerously anti-Imperial cable system, our haphazard means of controlling movements of population—these are among the other matters which must hereafter be viewed from the new Empire angle.

In working out these problems we shall inevitably change the character of our attitude towards those parts of the Empire which are not autonomous and with foreign nations which stand in intimate social or commercial relationship with us. India has assumed an entirely new place in the mind of the Canadian, the Australian, the New Zealander, who have fought side by side with the magnificent King's soldiers from that great dependency. Also a Canada which is a fully-equipped partner in the British Empire, and holds half a million men of proved efficiency in the art of war in its most deadly modern form, cannot be the same Canada to the United States as it was before the war. That it will remain a friendly and neighbourly Canada in its attitude towards the great English-speaking community across the Atlantic is, I believe, beyond any shadow of a doubt; but the new differentiation of national ideals which the war has set up on the North American continent must have profound and far-reaching consequences.

In the pursuit of the new path of Empire partnership our statesmen and the statesmen of other lands—and especially the men of the departments who feed the minds and guide the actions of statesmen—will have to recognise, far more fully than many yet do, that the old order has passed away beyond recall. Secure we must be as an Empire, and the price of security must be paid in the abandonment of many old dogmas and predilections. Many of us will say with Mr. Rhodes, when he was reproached with a changed mind, "Yes, I changed as quickly as I could, for I found I was wrong."

Summing-up.

There I must leave this fascinating theme. It would be easy to indulge in speculations as to the more remote means by which these great ends are likely to be attained. It pleases some among us to fashion beautiful Empire fabrics and dream beautiful Empire dreams. My immediate purpose is to indicate the *next* steps in Empire partnership, feeling certain, as I do, that the surest line of advance is from what is to what shall be. These next steps, as I see them, are clear and full of promise. There can be no such thing as finality of method in the development of an Empire such as ours. We move step by step as the need arises, and we may well take comfort in the knowledge that even in this time of severe trial we are adapting ourselves, both in thought and method, to what is no less than a revolution.

May I remind you of these next steps in a few bald sentences, and if they seem dogmatic, as they are not meant to be, please put that semblance down to the necessities of time and space?

1. No centralisation of the armies of the Empire under the supreme control of Whitehall is possible or desirable, but our co-operation on the battlefield should now ensure a far closer co-ordination of system and methods of military administration and a more adequate and permanent representation of the Dominions upon the Imperial Committee of Defence and in places of command. Moreover, every self-governing community is hereafter likely to seek greater security in some form of national military training after the manner of the Australian cadet system and our own Public School O.T.C.'s.

2. Realising that not only our Empire, but also our conception of civilisation, has been saved by an instantly omnipotent and therefore necessarily centralised Navy, it is probable that the

Dominions will desire to take a far more direct and proportionate share in the naval defence which they see to be their bulwark as well as ours. A representative Imperial Navy Board visiting the Dominions as occasion may suggest, and working in close association with the Board of Admiralty and Naval War Staff, would provide the Dominions with a share in naval administration and control; an Imperial Squadron would represent the Empire successively in every sea; and each Dominion would provide its own additional local naval force as its circumstances made necessary.

3. In the creation of the new third arm of defence—the defence of the air—the Dominions are also taking an increasing share.

4. After the war each Dominion should be encouraged to supply a proportionate share of the materials of defence, so that our forces may be able to count upon the industrialism of the whole Empire, even to a greater degree than in the present war.

5. As a necessary sequel to the means by which we are pursuing the present war, the finances of the States of the Empire are far more closely intertwined than they have ever been before, and a differentiation of taxes upon Empire as distinct from foreign investments should provide greater mutual financial support.

6. By every conceivable means of co-operation—governmental, legislative and commercial—the resources of the Empire should be developed for the benefit of the peoples of the Empire, rather than the peoples of foreign lands. The Dominions Royal Commission should be strengthened and reconstituted to take immediate stock of these resources and point the way to their development. It might be made an Imperial Development Commission to include India and other dependencies as well as the Dominions, and thus be representative of the whole Empire, work under a Minister of Cabinet rank and in cordial co-operation with the local Development or Conservation Commissions such as exist here and in Canada. The efforts of the Dominions and India to eliminate the foreign control of their metal and other products should be resolutely and consistently supported with a view to their use in Overseas and British industries rather than in those of our potential enemies. In the external purchases of the spending departments of each section of the Empire an administrative preference should be given to goods of Empire origin, and a substantial Empire preference upon import duties should be made an integral part of the fiscal system of the United Kingdom, as it already is of those of the Dominions.

7. As a natural accompaniment of this new commercial solidarity, the cable system of the Empire must be developed and more completely freed from foreign control, after the manner of the jointly-owned Pacific Cable.

8. The navigation laws of the Empire are also capable of adjustment to fit the new conditions, somewhat on the lines which successive Australian Governments have advocated at the Imperial Conference.

9. Men as well as money being the chief essentials for the development of overseas resources, the land settlement problem after the war calls for practical co-operation between the Home and Dominion Governments. The scheme which Lord Shaughnessy, the President of the Canadian Pacific Railway, is now initiating in the Canadian West offers much guidance in this matter.

10. The treaty system of the Empire had manifestly broken down before the war under the pressure of the new needs of the Dominions in their overseas trade. The war has brought an entirely new set of factors into play. The cosmopolitanism of the most-favoured-nation method is doomed, and in replacing it by the old English method of concession for concession means may be found for bringing in the Dominions as fully-accredited partners in all future negotiations with foreign Powers.

11. The haphazard and irregular character of the fiscal and treaty-making functions of the States of the Empire has been one of the main causes of past difficulties with foreign States, as, for instance, with Germany and the United States, and the removal of this cause of friction may open the way to more intimate, united and mutually advantageous relations between each autonomous part of the Empire, and those foreign Powers whom we desire to call our friends.

12. The diplomatic and consular services must be broadened and, may I say, purified of their alien character, to represent the wider requirements of the new Imperialism, and the public here and overseas must be taken far more into the confidence of the diplomatists in respect of the foreign relations of the Empire. Much of the past secrecy of diplomacy is as unnecessary as it is pernicious.

13. These developments affect, for the most part, matters which are the subject of executive rather than Parliamentary action, and hence the paramount importance of the wider Imperial

status which is being given to the Cabinet, supported by such representative bodies as the Imperial Conference, upon which India should now be represented, and the Imperial Committee of Defence.

14. Any notion of an Imperial Parliament, with a central Imperial Exchequer, an Imperial Zollverein, or other rigid political or economic uniformity, centralised in London, is not within our present range of vision. No Dominion will abandon or whittle away its control over its own tariff and internal affairs. But the closer association of the States of the Empire in defence, mutual tariff and other preferences, joint treaty relations with foreign countries, united efforts to encourage production and improve communications and so on, requires a closer co-ordination of executive methods. Through the Imperial Committee of Defence we have found a means of executive intimacy in defence and in a measure also in foreign policy. Why not also in the economic unity of the Empire which, like defence and foreign policy, should now be removed from party controversy? As the day-to-day associations of the Governments of the Empire develop, so will the interrelation of those Governments increase with possibilities of closer organic union, the exact character of which it is not possible as yet to divine.

THE WIDER HORIZON.

In one year of war we have learnt more than a decade of peace could have taught us of the art of "getting into the closest possible touch with one another." We all now see that in this unity of purpose and action our strength lies. We no longer fear, as many of us did in days not long past, that the time was approaching when, as in the case of every other Empire that the world has known, decay and ultimate dissolution would bring ruin to the work of centuries. We have become imbued with a new sense of the far-reaching mission we have to fulfil together. Without boasting, we may now claim with Sir Wilfrid Laurier that we answer to a "higher destiny," and, in the words of Sir Robert Borden, "it has once for all been borne in upon the minds and souls of all of us that the great policies which touch and control the issues of peace and war concern more than the peoples of these islands." Our public life has a wider horizon, and it must be made wider still. From the blood-soaked mud of Flanders and ravines of Gallipoli the message of Empire has gone to the humblest village of England, the loneliest shack of the prairie and the range, and the politician here or overseas who is deaf to the new impulse and fails to make it the inspiration of his words and action will, I hope and believe, write his own inglorious epitaph.

[The discussion on this paper will be published in the next number of the *Journal*, Friday, April 21st.]

BARBADOS SUGAR CROP.

The Barbados cane crop for 1915 showed an estimated production of sugar amounting to 22,000 tons of dark crystals, 15,000 tons of centrifugal muscovado, 200 tons of muscovado, 30,000 puncheons of syrup, and 16,000 puncheons of molasses.

The average local price has been 14*s*. 10*d*. for crystals, 13*s*. 7*d*. for centrifugals, and 12*s*. 4*d*. for muscovado; syrup, 10*d*. per gallon, with 2*d*. additional for package; molasses, 7½*d*. per gallon, with 2*d*. additional for package.

On account of extreme drought during the early part of the growing season, the production is about 8,000 tons below the average.

According to a report by the United States Consul in Barbados, the weather conditions at the time of writing were exceptionally favourable for the crop to be harvested this year, and with continued good weather the island should produce nearly double the one last harvested.

TIMBER IN BRAZIL.

Brazil is a country of vast variety in timber, and it is calculated that there are more than 5,000 species yielding useful wood, of which at least forty are first-class woods.

M. Gouzaga de Compos, a Brazilian expert, gives the total forest area of Brazil as 58 per cent. of the total area, but this estimate includes damaged forests. All the States possess timber of superior quality, but as yet the timber trade has not been much developed, owing to difficulties of transport, costly rates, and a lack of good ports for quick loading and shipping.

The chief exports are from the south of Brazil by the ports of Paranagua, Rio de Janeiro, and Santos. In 1911, only 821 tons were exported, and in 1912, 1,492 tons. According to a recent report by H.M. Legation at Rio de Janeiro, the thickness and impenetrability of the Amazon forests has so far prevented the export of the valuable woods abounding in these regions.

Lumbering regions are practically confined to the south, where the South Brazil Lumber Co. has set up several saw-mills along the Brazil Railway line. With the exception of that at Tres Barres, which has the most up-to-date appliances, these are of a somewhat primitive character. At Sanges and Calman it is expected that modern mills will be established before long.

The most valuable woods in the south are the Imbuya and the Parana pine. The former resembles mahogany, is a very hard wood, and is used for furniture at São Paulo. It also supplies sleepers for the Brazil Railway and other lines.

The straight trunk and freedom from limbs of the Parana pine make it easily handled by the mills, and it has very hard knots containing a great quantity of resin, which is used for pitch on the railways. Unlike other pines, it does not yield turpentine in sufficient quantities to make this a marketable commodity. The wood is sent to Curityba, São Paulo and Rio de Janeiro for building purposes.

No steps, adds the Legation report, have yet been taken, except by the Parana Government, and possibly also by far-seeing private proprietors, to regulate lumbering operations. Dr. Pedro de Toledo, the ex-Minister of Agriculture, proposed a Federal service in 1911, but his scheme has not yet been voted on by Congress. The railways show no discrimination in cutting down, for fuel purposes, large areas of valuable forest. The peasant in the interior burns quantities of valuable timber in order to cultivate a few hectares of land.

OBITUARY.

Colonel Sir Colin Campbell Scott-Moncrieff, K.C.S.I., K.C.M.G.—Sir Colin Scott-Moncrieff, who died in London on the 6th inst. at the age of eighty, was elected a member of the Society in 1895. He served as a Member of Council from 1903 to 1910, and was a Member of the Indian Section Committee from the time of his election on the Council down to the present date. He took the chair at the reading of Mr. Archibald Colquhoun's paper on Bosnia and Herzegovina, in February, 1909, and on several occasions spoke in the discussions on Indian and Colonial papers.

He went out to India in 1856 as a second lieutenant in the Bengal Engineers, from which regiment he retired as colonel in 1883. His main work in India was connected with the Irrigation Department of the North-West Provinces. He was also Chief Engineer in Burma. On leaving India he was appointed Under Secretary in the Public Works Department at Cairo, in which capacity he had charge of the Egyptian irrigation works. The chief work of his life was the completion of the Nile Barrage, and it is with this that his name will always be associated. After leaving Egypt he served as Under-Secretary for Scotland from 1892 to 1902. He was made a K.C.M.G. in 1887, and a K.C.S.I. in 1903.

Major John Fenwick Dickson.—Major John Fenwick Dickson, of Houston, Texas, U.S.A., died on March 5th, in his eighty-fourth year. He was born in Ireland in 1832, and emigrated to America in 1850. For some years he was connected with the locomotive works of several railways, and in 1869 he went to Texas to take over the management of the railway line then known as the Southern Pacific—a short line afterwards merged into the Texas and Pacific, the terminus of which was at San Diego, California. In 1887 he started the Dickson Car Wheel Company, which has since developed into an enterprise of considerable importance, and is stated to be one of the finest wheel foundries in the United States. He was also connected with the lumber industry, and with other branches of business, and was reputed to be one of the leading industrial men of Texas. Major Dickson became a Fellow of the Society in 1913.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 17...Geographical Society, Burlington-gardens, W., 8.30 p.m. Mr. H. W. Fox, "The Development of Rhodesia from a Geographical Standpoint."

Actuaries, Institute of, Staple Inn Hall, Holborn, W.C., 5 p.m.

Tuesday, April 18...London Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 5.30 p.m. Mr. W. R. Davidge, "The Development of London."

Petroleum Technologists, Institution of, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. 1. Address by President, Professor J. Cadman. 2. Mr. E. H. C. Craig, "Kerogen and Kerogen-Shales."

Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m.

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Annual General Meeting.

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Mr. R. I. Pocock, "On the External Characters of the Mongooses (Mungotidæ)." 2. Major H. Muir Evans, "The Poison-Organ of the Sting-Ray (*Trygon pastinaca*)."

Wednesday, April 19...Meteorological Society, 70, Victoria-street, S.W., 7.30 p.m. 1. Mr. E. V. Newnham, "The Persistence of Wet and Dry Weather." 2. Professor H. H. Turner, "Discontinuities in Meteorological Phenomena."

Microscopical Society, 20, Hanover-square, W., 8 p.m. 1. Professor B. Moore, "Early Stages in the Evolution of Life." 2. Mr. F. M. Duncan, "Studies in Marine Biology." 3. Mr. J. W. Purkiss, "Some Suggestions regarding Visual Efficiency in the use of the Microscope and other Optical Instruments."

Literature, Royal Society of, 20, Hanover-square, W., 5.15 p.m. Professor W. de la Mare, "Truth to Life."

Labour Co-partnership Association, Central Hall, Westminster, S.W., 3 p.m. Mr. F. Maddison, "Co-partnership after the War."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.30 p.m.

A Fellow of the Society is anxious to purchase Vols. I. and II. of the *Journal of the Royal Society of Arts*, published in 1852 and 1853. Anyone having these volumes to dispose of, should communicate with the Secretary, Royal Society of Arts, Adelphi, W.C., stating the price for which he is willing to sell them.

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FRIDAY, APRIL 21, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

THURSDAY, APRIL 27th, 4.30 p.m. (Indian Section.) JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India."

In the absence of Mr. J. MacKenna, the paper will be read by Sir Steyning W. Edgerley, K.C.S.I., K.C.V.O., C.I.E., Chairman of the Indian Section.

Further particulars of the Society's meetings will be found at the end of this number.

EASTER HOLIDAYS.

The office of the Society will be closed from the 21st inst. (Good Friday) until the following Wednesday morning, the 26th inst.

JOURNAL.

The Government limitations on the importation of paper and paper-making materials have rendered it necessary to restrict the *Journal* to the smallest possible size. For the present, therefore, its contents will be confined as far as possible to a report of the actual proceedings of the Society, and it may be necessary occasionally to publish reports of the meetings a little less promptly than has always been the practice.

It is hoped that the Fellows will appreciate the necessity of such restrictions, and it is also hoped that the *Journal* may be able to expand to its normal size at an early date.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, March 28th, 1916; DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, in the chair. The paper read was "Next Steps in Empire Partnership." By PERCY HURD.

The text of the paper was printed in last week's *Journal*. The following is the discussion on the paper:—

DISCUSSION.

MR. W. A. S. HEWINS, M.P., M.A., in opening the discussion, said that the British Empire consisted of the United Kingdom, the great self-governing Dominions, India, and the great Crown Colonies and Protectorates, in which there was every kind of civilisation, representatives of every race and religion, every form of Constitution known to man, and every stage of political evolution. At the present time all its myriads of activities were united in a common cause against the enemy, one of the most stupendous facts in its real significance that could possibly be imagined. Attention should be concentrated all the time on the action of the men of the Empire rather than on any theories that might be held about the future constitution of the Empire. Everything turned upon the attitude of the Empire, and what it did in the present state of war. It was perfectly clear that, in view of the resolution adopted by the House of Commons, a new phase of development altogether had been reached in the contemplation of an economic alliance between the British Empire and its Allies; but obviously it was necessary to know what the Empire meant to do itself before entering into final arrangements with other countries. Whatever decisions the Home Government arrived at must be on lines which appealed to the great self-governing portions of the Empire, and when that was done he thought it would be found that the new facts which emerged would put a new complexion upon most of the problems which had to be solved. If it was decided to terminate the German control of the metal resources of the Empire, it meant most important modifications of the whole economic system of Germany, and a shifting of the economic power in Europe. The Empire had fully made up its mind to terminate once for all German control of its resources. When the organisation

of the Empire for the purposes of war, in association with its Allies, was taken in hand in a practical sense, not only would great Imperial problems have to be faced, but to a very large extent the future development of the civilised world. He believed the peoples of the Empire were equal to that task, although he had very little confidence in the people of the past two generations, who had been in command for the last fifty years and had allowed principles to be adopted and acted upon which, in view of the evidence forthcoming from the war, would have wrecked the British Empire. But he believed in the young men and young women of the Empire, and had the greatest confidence in what they would effect in the future, in view of the stupendous feats of organisation which had been performed by them in the conduct of the war. If tables were made showing the course of the economic development of trade, agriculture, and finance, and they were reduced to curves, wonderful fluctuations extending all over the world would be seen; but behind those curves of development there was a great silent power which was moulding events, but which was not at present thoroughly grasped. In spite of all the blunders of the past sixty years of a deliberate policy against the interests of the Empire, that great movement had gone on steadily and silently, under the impulse of unseen forces, and was leading to a more complete organisation of the Empire on the broad features of the English principle which had been known for hundreds of years. Many people who talked about the Empire took a slightly too materialistic view of the matter. The British Empire was not a great association for increasing mutual wealth, or even for illustrating certain political principles of organisation. The very form of the Empire, the different grades of organisation and of political evolution, and the plane above plane of social structure, pointed to something still higher. There was an ideal, and it was in those permanent fundamental principles of justice, fairness, and integrity that the ultimate end for which the British Empire really existed was seen. If the British Empire as a whole got under what he would call German influence, and took the great material forms of wealth as the aim for which it lived, he did not believe it would have any other end than that which he trusted would be reached by the present German Empire. The materialistic forms of organisation, wealth, resources, and man power, had to be put in their places as mere instruments with which the individuals who composed the Empire secured those higher ends without which life was not worth living.

The Hon. F. W. Young, LL.B., Agent-General for South Australia, thought that a broader Imperial outlook amongst all classes was urgently needed at the present moment, so that the future they had to meet might be more fully appreciated, and the necessary decisive actions taken to make that attitude effective. Although he had been in this country for only a comparatively short time, he had been impressed with its immovability. There was to some extent a want of virility of thought and action if the country, as the great centre of the Empire, was to reap the full fruits of everything within the Empire. He discovered that, after the war had existed for twelve months, those interested in copper in South Australia experienced great difficulty in selling that commodity in Great Britain, but after many negotiations a satisfactory alteration of the position was obtained, the final statement which reached him being that the reason South Australian copper had not been purchased was that the Home Government had been able to procure plenty from America. That betrayed a want of outlook in the official world which would, if continued, kill the possibilities of the Empire as Imperialists would like to see them develop. He appreciated that it would be wiser to concentrate their minds at present on the steps that should be taken towards a closer union than to contemplate too seriously the final end in the shape of some rigid Constitution. He believed the immense strength of the moment was due to the looseness of the past. The British people seemed to resist the rigidity of Constitutions, with the result that there was at present a Constitution in this country which it was almost impossible to put on paper. But, with all its faults and muddling, it had to be realised that the people under that Constitution had achieved wonderful things, and that fact should not be ignored in regarding the future. Having behind them and before them the common blood, language, and traditions, if a closer, common interest in defence and in trade were associated with them, a great deal would be accomplished towards effecting the closer union desired throughout all parts of the Empire. The author had referred to the double income tax question, and the attitude of the Exchequer towards it since 1896 at least. At the last Imperial Conference in 1911, the Lords of the Treasury submitted some reasons why the present system of taxation should not be altered, one being that a citizen of Australia, for the time being resident in Great Britain but still having wealth in Australia, was *pro tanto* a citizen of two countries, and it was, therefore, not inequitable that he should pay two taxes. That was the kind of outlook that had to be abolished if a move forward was to be made on Imperial lines. Australia produced one-fifth of the world's supply of zinc and lead, and it was not sufficiently realised that Great Britain was not dependent upon the rest of the world for its metals. Everyone had made up his mind that the German control of the minerals in the Empire was to cease entirely, but it was necessary to go one step further and see that the British Empire took up effective control of those metals, because the mines had to be worked, the men employed, and the produce turned to good account. Therefore, if the German and Austrian manufactories were

shut down it would be necessary to start new manufactories in the British Empire. They were very important industries from a peace point of view, but they were vital to our existence in time of stress. It was to be hoped that the lesson of the present moment would not be lost, and that the people of the Empire would, regardless of past beliefs, adopt a vigorous outlook in regard to all the problems concerned, and do what was felt to be necessary. Only on those lines could they expect to go ahead, as they ought to, as the British Empire.

MR. JAMES SWINBURNE, F.R.S., thought the question of the commercial position after the war was very pressing, because at the present time there was a general tendency towards a reversion to Protection. The Dominions had every facility for producing metals, wool, food, and live-stock; but practically all of them objected to taking imports, and therefore adopted what they called Protection, *i.e.*, they made it difficult for imports to get into the country, thereby stopping exports. By hindering exports their people were turned on to do things which they did badly, and were taken away from things they could do well. As a result, they were not growing as fast as they would if that were not the case. The old idea used to be that a country ought to export, and take in no imports but gold, but as Australia was a gold-producing country it was an example to show the fallacy of the argument. Australia had only as many cattle as England, and three times as many sheep. Surely she should grow very much faster. It was of the utmost importance that the Dominions should grow very fast, because it was undesirable that all the population should be found in one corner of the world. If the British Empire was to be still more powerful, Australia should be so large and powerful that she could hold her own if necessary against any future enemies in her own part of the world. He suggested that Australia was not going the right way to help herself in that respect, because by cutting down her imports, and thereby cutting down her exports, she was injuring herself and other countries as well—for instance, England. A large amount of frozen meat was obtained at present from Argentina which ought to be obtained from Australia and New Zealand, but that was impossible if those countries refused the imports that must enter in exchange for those commodities. He did not think the question of how Germany was to be dealt with was the problem that had to be considered; the real one was how we were going to deal with ourselves. A course ought to be shaped so as to make the Empire grow as fast as possible. Once it was realised that Protection, as it was called, was not protection at all, but the throttling of external trade, it would be apparent that the word "Protection," as used in that sense, was absurd. The words "Preferential" and "Reform" were also in the same category. One hundred and fifty years ago Adam Smith pointed out the absurdity of the idea that exports should be encouraged and imports discouraged. In the old days people objected to machinery because they said a machine did the work of twenty men and thus caused unemployment. The fallacy there was that people thought employment was a good thing and production a bad thing, whereas it was exactly the reverse. This was the most important popular economic fallacy in existence, and was the fundamental argument of the Protectionist. It would be impossible to get an indemnity out of Germany if imports were objected to, because the only way the Allies would get an indemnity would be in the form of imports. The more the Germans dumped goods into this country, the more we should get in the way of an indemnity. Dumping was a splendid thing for the countries that received the goods, and very bad for the countries sending them. He did not believe any Acts of Parliament would be of use in helping trade; they always injured it. The only thing that could be done was to be more efficient in our manufactures, both in the Dominions and in England. Some of the Dominions had laws against the entry of black men into their countries. He would like to see not only the Dominions but the whole of the Allies make a law extending that from the people who had black outsides to the people who were black inside. The Germans ought to be kept out of the Empire as much as possible; but apart from that he believed the real solution of the difficulty was to increase our production in every possible way, and stop any kind of legislation that tended to reduce it.

SIR FRANCIS PIGGOTT, LL.M., late Chief Justice, Hong-Kong, observed that the premiers of the Dominions claimed to take a share in the policies which tended to peace or war in the Empire, but how that problem was to be dealt with was another matter. He agreed with the author that it was necessary to get rid of all the little pitfalls that existed, but it must be remembered that, when dealing with the creation of a new Constitution to admit the Dominions into the councils of the Empire it must be written down, and before that could be done it would have to be ascertained what the British Constitution was. At the present time, however, there were no two books on that subject that were in agreement. It was a problem so full of difficulties that it would require a lengthy discussion for its elucidation. Referring to Mr. Young's remarks on the subject of double income tax, he referred to another illustration from his own experience. In 1887, at the time of the first Imperial Conference, he suggested that judgments in the Colonies and in different parts of the Empire should be executed in other parts of the Empire, just as Scottish and Irish judgments were executed in the Kingdom. The Dominions agreed to the suggestion, but nothing had been done in that direction for thirty years. There were innumer-

able numbers of minute problems of that nature which awaited solution and which were all essential parts of the great general problem.

Mr. James Roberts, M.A., LL.B., advocated the formation of an Imperial Cabinet, with the object of advising His Majesty in all matters which were not exclusively the domestic concerns of the United Kingdom. This Cabinet, he considered, should consist of a definite number of members, half of whom might be British and the other half Dominion representatives. If this plan were adopted, should a General Election take place at home, foreign affairs would automatically be removed, to a very great extent, from the sphere of party politics, because only half of the composition of the Imperial Cabinet would be changed, and uniformity of policy would thus be obtained. The numbers of the representatives of the respective Dominions would necessarily be fixed, but in all other respects the filling up of their seats in the Cabinet should be left to themselves. For they might prefer to send delegates from their Governments, and continue the practice of excluding foreign affairs from their elections. The British half of this Cabinet would include the British Ministers of Foreign Affairs, War, and the like Imperial offices. In such a scheme the difficulties attending a single Imperial Parliament would be avoided, and it could be brought into operation forthwith without legislation, by making the nominees of the Dominions members of the Privy Council.

The Chairman (Dr. Dugald Clerk), in moving a vote of thanks to the author for his most interesting paper, said it must particularly be borne in mind that the British Empire had attained its present position notwithstanding all the "muddlement," the illogical arrangements, and want of a written Constitution, to which Mr. Hurd had called attention. There could be no doubt that one of the greatest strengths of the British Empire was that it had no written Constitution. British law was as much judge-made law as Parliament-made law, and there was a tremendous flexibility in the British method, due to what might be called a want of method. The Constitution of the United States, which was a written one, was at present the greatest stumbling-block to the advance of America. It was a definite written document, with cast-iron provisions, made many years ago, which did not in any way fit the conditions at the present time. As a result, American lawyers were always endeavouring, with great dialectical ingenuity, to get out of their own Constitution, and a great many of the things now done by the American Executive were done outside of the Constitution. The British Constitution was the result of a long organic struggle; the British Empire was like a complicated organism, which it was very difficult to understand. The French legal code looked very beautiful, but French justice was not as good as English justice, and German was still worse. Germany had carried method to a degree of madness. The curious thing to his mind about most things German was that the German came with great precision to an erroneous decision. The German very rarely indeed came to a correct decision. A German first of all made a very fine logical statement, but wound up with a conclusion, generally speaking, in direct opposition to the statement. That was how the Germans managed to persuade themselves, firstly, that the British Empire was a thing of straw; secondly, that the people in it were cowards; and, thirdly, that German science and industry were the most glorious things in the world. People in this country, as in all democratic countries, did not hesitate to say what they thought of each other, and outsiders thought that, because we said we were going to the dogs, that was really the case. As a matter of fact, at the end of the war England would be the strongest country in the world.

Sir William Duke, K.C.I.E, seconded the motion, which was carried unanimously, and Mr. Hurd acknowledged the compliment.

The Chairman expressed the thanks of the Society to Mr. MacLaren Brown, of the Canadian Pacific Railway, for the use of the diagrams with which the paper was illustrated.

Mr. Hurd, in acknowledging the vote of thanks, especially welcomed the suggestive speeches of Mr. Hewins, Mr. Young and Sir Francis Piggott, and added: As Mr. Hewins has so well said, there is underlying and inspiring this Empire movement an idealism as fine as anything that has ever animated the nations of the world. It is for us to live up to that idealism. In our public and departmental life here in England we needed the invigoration and initiative which comes to us from contact with these younger Englands overseas, and the Dominions on their part had shown by their splendid comradeship in the trials of war how highly they valued the high traditions of justice and freedom which have their source in these little islands.

JAPANESE ENTERPRISE IN KOREA.

A report on the various enterprises undertaken and carried out in Korea by the Japanese during the three years following their annexation of that country has recently been made by Count Terauchi, the Governor-General of Korea, to the Emperor at Tokio. Included in this publication are the more noteworthy of the proclamations and instructions issued by the Governor-General during this period. Among the topics that are touched upon, says the United States Consul-General at Seoul, are the cultivation of cotton, stock farming, sericulture, the production of rice, and the regulations intended to increase efficiency in handling goods at the custom-house.

Count Terauchi's statement refers to the fact that Japanese migrating to Korea have been steadily increasing in numbers since the annexation. In 1910 the Japanese living in the peninsula numbered only about 146,000, forming some 43,000 households. In June, 1913, the figures had increased to more than 264,000 and 75,000 respectively, showing increases in the interval of three years of more than 118,000 in population and 32,000 in households.

In former days Japanese residents in Korea mostly congregated in the open ports and vicinity and engaged in the import and export trade, or in retail business on a small scale. After annexation, however, when peace was generally restored in the interior, and travelling and habitation by Japanese became safe, the number of Japanese settling in important places outside the open ports and engaged in mining, agriculture, fishing, transportation and other lines of business steadily increased.

Especially noteworthy is the fact that Japanese engaged in agriculture, an industry which requires much time before substantial profits can be obtained from it, have changed their method of conducting it. Formerly, Japanese buying paddy and dry fields in Korea aimed at obtaining incomes by renting them to Korean tenants, or reaping profits by reselling them. Now those undertaking agricultural industry themselves are gradually increasing.

Besides, as a result of the efforts put forth by the Oriental Development Company, under Government directions, to encourage the emigration of Japanese farmers, the number of those farmers living in Korea has greatly increased. Thus, at the time of annexation the total number of their households was about 2,130. These figures increased to 2,960 during the following year (1911), and further increased to 4,380 during 1912, showing an increase to more than double those in the year of annexation.

In former days it was usual for Japanese fishermen to come to Korea only during the fishing season, but in recent years many have settled permanently in localities along the coast and are engaged in their business in partnership with Korean fishermen.

Further, in all branches of industry, such as agriculture, technical industry, and commerce, Japanese undertaking these employ many Koreans as their business assistants and workmen, and there are also to be found many instances in which Japanese and Koreans are jointly undertaking business.

Cotton can be cultivated with advantage in all parts of Korea, but cotton of native species has been found not quite good enough for spinning purposes. In consequence, measures were taken to improve it. At the same time, it being recognised that cotton of the American upland species grows well in South Korea, the former Korean Government, under direction of the Residency General, put forth efforts for encouraging its cultivation in that part of the peninsula by establishing at Mokpo a temporary station for the experimental cultivation of American cotton. After annexation, in order to promote its cultivation by Korean farmers still more widely, the station was converted into a branch of the model agricultural station at Suwon, and experts with experience in the cultivation of cotton were appointed to offices of prefectures and districts suitable for the cultivation of upland cotton.

Further, guilds of cultivators of cotton were formed; farmers showing themselves specially zealous in the cultivation of upland cotton were publicly rewarded by the presentation of agricultural implements, and the produce of places having difficulty of disposing of it was made saleable by the cultivators being given subsidies toward the cost of transportation. In these ways the cultivation of upland cotton was most vigorously encouraged with a very satisfactory result.

Thus, whereas in the year when annexation was carried out the area of land devoted to the cultivation of upland cotton was about 1,000 cho, and its cultivators numbered less than 20,000, in 1912 the area increased to about 6,500 cho, and cultivators to 77,000, while in 1913 the area reached 14,000 cho (one square cho = 2·45 acres). As to the amoun of cotton exported to Japan, while it was only valued at about 250,000 yen in 1910, it increased to 920,000 yen in 1913.

Like other branches of the agricultural industry, sericulture was also formerly in a very undeveloped condition. Silk cocoons produced in Korea were inferior in quality and diverse in variety. The mulberry leaves used were also very inferior in quality, and mulberry orchards were limited in area. In short, the condition of the sericulture industry in the peninsula was anything but satisfactory. In order to raise it, therefore, measures were first taken to cause the model agricultural station and provincial nurseries to rear and distribute among Koreans seedlings of the best varieties of mulberry trees imported from Japan. Subsidies were also granted to people forming mulberry orchards, so that the cultivation of these seedlings might be encouraged and the area of mulberry orchards enlarged.

Koreans soon found that leaves of Japanese mulberry trees were superior in every respect when compared with those of Korean trees, and the number of people cultivating them steadily increased. In 1912 the total area of orchards planted with Japanese mulberry trees reached about 1,600 cho throughout the peninsula. Also, in order to do away with the variety of native silk cocoons, the model agricultural station was charged with the task of selecting species best suited to the climate of Korea. The result was that three varieties of spring breed, one variety of summer breed, and one variety of autumn breed were selected, and eggs obtained from these five varieties of silkworms by the

model agricultural station were distributed among provincial offices, which then undertook, through various sericultural organs, the distribution of the eggs among individual people engaged in sericulture.

As silkworms hatched from these eggs were found to be very strong in resisting diseases and their cocoons were excellent in quality, the hatching of silkworms from eggs of the improved species rapidly became general, and the demand for cocoons spun by them also greatly increased, while the price quoted was three times that given for cocoons of the native species. As people in general outside agricultural people can engage in the sericulture industry with comparative ease, those undertaking it increased in number remarkably, and the total crop obtained in 1913, including spring, summer, and autumn breeds, amounted to as much as 35,400 koku, whereas that obtained in 1909, the year preceding annexation, amounted only to 11,900 koku (koku = 4·96 bushels).

Cattle are indispensable to the agricultural industry in Korea, and occupy a prominent position in the list of items of the export trade of the country. Great attention was paid to the improvement and increase of the breed. Further, in all local centres people were induced to organise cattle guilds among themselves, and to these experts were appointed to teach them the method of increasing their stock. The slaughter of cows in calf was restricted. By means of these measures, without depending on foreign breeds, the improvement and increase of the native breed best adapted to the soil and climate of Korea were undertaken and the result obtained was very satisfactory. Thus, whereas the total number of cattle in Korea was 628,000 in 1909, and 703,000 in 1910, the year of annexation, it increased to 906,000 in 1911, and to 1,040,000 in 1912. Now, Korean cattle being in great demand at Vladivostok and in other parts of Siberia, as well as in Japan, there is little doubt that they will become one of the most important products of Korea.

The encouragement of afforestation is what is most closely connected with the improvement of the agricultural industry. In Korea, in consequence of the ruthless felling of trees and the denudation of mountains, floods or drought frequently occur, and not only the agricultural industry but roads and railways suffer much damage. In order, therefore, to eradicate the evil the authorities early undertook to encourage afforestation among the people.

In 1908 the Residency General caused the Korean Government to provide regulations for the administration of forests in general, as well as for the management of State-owned forests, and thus fixed a general policy with regard to afforestation work in this peninsula. After annexation, in 1911, in order to complete the adjustment of forests and foster in the minds of the people at large the love of forests, the old regulations were abolished and new forestry regulations and some minor regulations relating thereto were promulgated.

At the same time strenuous efforts were put forth to encourage afforestation work. First of all, after due investigation of State-owned forests, those most needing protection were selected and their areas fixed, special offices for supervising them being created.

As for those State-owned forests the retention of which as such was considered unnecessary, it was arranged that these should be leased to private persons undertaking afforestation, and that if they succeeded in their work, the forests should be transferred to their possession.

In July, 1913, there existed throughout Korea 319 nurseries, including one maintained at State expense, 270 maintained by local revenue, and 48 maintained from proceeds from the Imperial donation fund. In these nurseries seedlings of pine, acacia, chestnut, poplar, and a few other trees were reared and distributed free. There are also not a few similar institutions established and managed by private persons and companies, and these contribute in no small degree to the spread of afforestation work.

In 1911, Arbour Day was established in Korea, April 3rd, a great national holiday, being fixed upon, and 4,650,000 young trees were planted on that day by officials and private persons throughout Korea. In 1912 there were 10,160,000 young trees planted, and 12,430,000 in 1913. The steady increases in figures will show how people in general are becoming cognisant of the benefit of afforestation.

INDIAN INDIGO.

The *Agricultural Journal of India* contains an interesting report by Mr. and Mrs. Howard of the progress which has been made in the improvement of indigo in Bihar in 1914. The principal value of the plant lies in the amount of indican contained in its leaves, though the by-product seeth, which consists of the plant residues after extraction of the indican, is an excellent manure. Indigo is a leguminous plant, and, as with all other similar crops in India, its well-being depends on the aëration of the root nodules. The essential points about these nodules are two. In the first place, they contain bacteria which have the power of assimilating the free nitrogen of the atmosphere, and working this up into materials from which the indigo plant makes the proteid it requires, and also the indican in its leaves. In the second, the food of the bacteria in the nodules is supplied by the plant, and for this purpose substances of the nature of sugar are passed down from the leaves into the nodule to feed the bacteria.

Leguminous plants, if grown in soil rich in nitrates, do not form nodules, but absorb the nitrates direct in the same manner as other plants do; and it must also be borne in mind that the

parts of the root which absorb water and minerals also require air, and will not work in the absence of oxygen.

The root nodules, consequently, develop most successfully when the plant is grown on somewhat poor land. When the soil contains little nitrate, the nodules work at high pressure to supply the proteids required by the plant; large amounts of the nitrogen and oxygen of the air are used up, and the leaves become rich in indican.

The activity of the root nodules reaches its maximum when the plant is ready to flower; and it is said that if the crop is allowed to flower the yield of finished indigo falls off and the colour suffers.

As regards the supply of air round the nodules, this is easily secured in Bihar during the earlier part of the season, provided that the soil is deeply cultivated and well broken up; but if there is a very heavy rainfall, so that the soil gets packed and the air spaces filled up with water for any length of time, the activity of the whole root system is stopped, no further indican can be formed, and the plant falls back upon the reserve indican stored in its leaves. From this it is clear that the first aim of the planter must be "to run the whole nodule factory to its highest pitch. Not only is the yield of indigo thus increased, but the condition of the finished product is improved and good colour results."

GEOLOGICAL NOTES ON QUEENSLAND.

From the Gulf of Carpentaria to the Darling Downs, north and south, the fossil remains of extinct mammalia have been found in indurated muds, the beds of old watercourses. The fossils are Diprotodon Australis, Macropus titan, Thylacoles, Phascolomys, Nototherium, crocodile teeth, etc. The Diprotodon inhabited the Queensland valleys freely, and the Crocodilus Australis had a great range inland. The Diprotodon remains are found chiefly in the most permanent water-holes. No human bones, flint flakes, or any kind of native weapons have yet been discovered with the extinct mammalia of Queensland.

Desert sandstone is the most recent widely-spread stratified deposit developed in Queensland. Since it became dry land the denudation of this formation has been excessive, but there is still a large tract *in situ*. Probably this desert sandstone covered the whole of Australia at one time. (It is possible that desert sandstone in Queensland has value for free gold.) On the vast plains west of the dividing range cretaceous strata are found; hot alkaline springs occur in these plains, and the discovery of these suggested the possibility of the existence of artesian water long before the bores were sunk, from which flow "Queensland's rivers of gold."

The whole of Queensland is a vast cemetery of fossilised species—on the surface, buried in drifts, or hidden in clays. The plains of the Flinders River disclose great deposits of marine fossil shells, belemnites and ammonites, and remains of extinct animals. In the Gulf of Carpentaria, 40 or 50 feet below the alluvial deposits forming the banks of rivers, firmly embedded in the hard cement—water-worn stones in an ironstone clay—are the bones of innumerable extinct gigantic animals that, far back in some prehistoric age, roamed over the Gulf country: diprotodon, nototherium, and zygomaturus—grass-eaters and flesh-eaters. The utter extinction of these creatures can only be explained by a great change of climate and great and lengthy droughts. The fossils are from animals of immense size; the teeth found are twice the size of an ordinary bullock's. Gigantic alligators, turtles and marsupials abounded in those days, suggesting a luxuriant and abundant herbage.

From an economic point of view one may say that three-fourths of the area of Queensland forms good pastoral land. Of this, 60,000 square miles contain valuable mines of gold, with outcrops of copper and lead ores, as well as rich deposits of tin; 24,000 square miles are capable of producing illimitable supplies of iron and coal. It may be safely asserted that in Queensland is a wealth of material resource comparing favourably with any other part of Australia.

FORESTRY AND TIMBER IN IRELAND.

The recent changes in the timber trade of Ireland have directed public attention afresh to the island's indigenous forest resources. It appears that afforestation has been receiving a measure of intelligent attention for the past decade or more. The Province of Munster possesses one-third of the wooded area of Ireland, and fells two-thirds of the annual cut of timber.

Of the total territory of Ireland, only 1·4 per cent. is under woods, as compared with 5·3 per cent. in England. Ireland has a lower proportion of its area in forests than any other country in Europe.

On the other hand, the exportations of wood and its manufactures in 1913 were valued at £474,000, and eight or ten of the country's substantial industries are based with some directness upon the native wood supply.

Although the stock of standing timber has been steadily depleted in recent years, the shrinkage in area is not striking. The highest recorded spread of forests is set down for the year 1880 at 339,858 acres, and during the ten years ended with 1913 the decline was only 5,495 acres. All authorities, however, both official and unofficial, insist in the strongest terms that the diminution of the timber supply cannot be gauged by area. Continuous selection and consumption of the best individual trees during a long series of years have left many so-called forest tracts practically devoid of processable wood, and it is doubtful if an average of more than 50 per cent. of a full crop can be found over the entire area returned as woodland.

On a forest area of 6,700 acres, chosen as typical, a thorough inspection in 1908 showed 47 per cent. virtually bare of valuable timber, 25 per cent. in tolerable condition, and only 28 per cent. properly stocked. As to age, 77 per cent. of the trees were over fifty years old and 45 per cent. were over seventy-five years old. Fresh corroborative data are supplied by the 1913 returns as to the age of standing forests. Out of 170,906 acres investigated, only 20,170 acres are below twenty-five years of age, while 98,469 are over fifty years of age, and 45,267 are from twenty-five to fifty years of age.

The number of trees felled in 1913 was 571,859, and the acres cleared were 1,462, while the number of trees planted was 2,488,162 on an area of 1,154 acres. The replanting thus fulfils the forestry principle that four times as many plantings as fellings should take place in any given year. The fellings, moreover, represent a decrease over former years, since the number of trees cut in 1911 was 903,341, and that in 1901 was 941,132. The weight of trees felled in 1913 was 245,210 tons, and this also indicates that cutting is not unduly rapid, since from one to two tons per acre is deemed a legitimate take in a well-managed forest, and the Irish acreage is 297,809.

As a less favourable consideration, it should be stated that in order to replace 300,000 acres every seventy-five years 4,000 acres should be replanted each year, as against 1,154 acres actually set out in 1913. A large share of the trees now standing are too old to be valuable for cutting and yet occupy forest ground. On the whole, the most hopeful feature is the wholesome increase in planting, the acreage now averaging about 1,100 per annum, as compared with 900 per annum during the years 1903 to 1907. In number of trees planted Leinster somewhat exceeds Munster, and the two provinces together plant two-thirds of the total for Ireland.

According to a report recently sent to his Government by the United States Consul at Cork, the decimation of standing timber in Ireland since 1900 has corresponded with similar developments in many other parts of the world, and has had similar causes, which are familiar to most persons. An additional cause in Ireland has been the breaking up of large landed estates, especially since 1904.

The findings of the Committee of the Department of Agriculture appointed in 1908 to report on the forestry situation dwelt on the need for conservation. Legislation was recommended to correct the disapproved tendencies of the Land Purchase Acts, and an elaborate scheme for national control of all forests with active management of a large part, not only of the afforestation, but of ordinary felling and marketing, was urged by the committee.

The amount of land available in Ireland for forest uses on sound economic lines was estimated at 1,000,000 acres, including existing woodlands, and this estimate was lower by half than previous assertions by forestry enthusiasts. The mountain land of Ireland is covered with wet peat, bare rock, or a gravelly porous soil, and only the latter is suited for trees. The peaty and rocky types of land predominate in the north and west. In general, the mountain land becomes less adapted for afforestation as the western coast is approached, and this is unfortunate, since the western parts of Ireland are least thickly populated, and therefore are most available, *primâ facie*, for forest planting.

The ideas of the committee were not put into effect, but their investigation increased the interest and intelligence shown in connection with the problems of replanting. Other influences in the same direction have been the Government Forestry School at Avondale and the Irish Forestry Society.

Varieties of Trees in Ireland.

Nondeciduous trees predominate in Irish forests. In 1913, of the total forest acreage (297,809), 93,640 were returned as conifers, 77,077 as broad-leaved, and 127,092 as mixed, with conifers probably predominating. The narrow-leaved class includes larch, fir, spruce, Scotch pine, etc., while the broad-leaved, or deciduous, covers oak, ash, beech, sycamore, birch, etc. The following table, compiled from various official sources, shows the acreage of each species in 1901 (the latest available year), and the number of each species felled and replanted in 1913:—

Varieties.	Area, 1901.	Felled, 1913.	Planted, 1913.
	Acres.	Number.	Number.
Larch	46,175	269,464	1,075,139
Fir	35,020	54,106	347,498
Spruce. . . .	15,291	26,073	268,425
Pine	3,377	23,379	185,020
Oak	25,158	47,375	54,900
Ash	7,398	15,830	44,360
Beech	9,826	26,837	69,340
Sycamore . . .	2,562	4,571	12,812
Elm	2,750	1,124	9,600
Other and mixed	162,184	106,100	421,068
Total . . .	309,741	574,859	2,488,162

It is evident that larch is easily the leading tree of Ireland, and also that nondeciduous trees are being planted more actively than broad-leaved varieties, although the latter are being freely cut down.

The most profitable ages at which the different varieties may be cut are as follows: Larch, 50-80 years; pine and spruce, 70-100 years; ash, 60-80 years; beech, elm, and sycamore, 80-100 years; and hedgerow trees of all kinds, 60-70 years. These figures presuppose healthy and sound trees, as a large share of trees in each variety develop defects, and must be cut earlier than indicated.

Of the 574,859 trees felled in 1913, 304,214 were used for mining purposes (mainly in England), 28,522 for railway ties, 17,357 for fencing, 6,269 for bobbins and spools, 24,538 for fuel, 74,404 for carpentry and furniture, 8,535 for vehicles and implements, 3,510 for clog soles, 1,300 for boat-building, and 17,266 for boxes. As to fuel, fencing, clog soles, and boxes, the proportions vary greatly in different years; but the heavy preponderance of the wood used for mining purposes (pit props) has been constantly maintained, and the proportion devoted to railway sleepers and to building and furniture appears to be fairly constant. There are 85 furniture factories in Ireland, 55 box-makers, 16 manufacturers of implement handles, 8 of bobbins and shuttles, and 8 of wheelbarrows; and basket-making, stave-making, and the making of boot-lasts, bog-oak souvenirs, walking-sticks, matches, and other articles are connected with the growth of timber and coppice in Ireland.

Except furniture, the principal kind of wood exported from Ireland is pit props. Practically all the rough timber is worked into various forms of struts and props for British collieries. The principal wood used is larch, with some fir and odd-size oak. The Lancashire and Scottish coal mines value larch more highly than do those of Wales. Before the war the Welsh collieries drew pit wood from Bordeaux and Bayonne in France, delivered at 20*s.* per ton at Cardiff, so that Irish sales to Wales were small. Scotch pine and spruce, which mature more slowly than larch, cannot profitably be grown for mining purposes, the Russian and Scandinavian wood of these varieties having gained the favour of the coal mines, which bid higher prices for it than for Irish wood. Larch remains, therefore, the logical Irish timber for mining use, as it can be harvested at thirty-five to forty years of age, the diameter being then 9 to 12 in. Scrub oak can also be thus used.

The exports of pit wood go almost wholly from Cork, Waterford, Wicklow, Wexford, and Tipperary, the five leading timber counties of Ireland. In 1913 the port of Cork alone exported 24,415 tons of rough timber.

For packing-cases, butter-boxes, egg-crates, etc., which are largely used in Ireland, Scotch pine and spruce of Irish growth are the leading woods, while poplar is sometimes used. Oak, ash, and beech are apt to be too heavy and too moist. Timber for boxes brings 8*s.* to 12*s.* 4*d.* per ton in the wood. The same varieties are used for railway sleepers. The price of these has risen by half within ten years, and now stands at 4*s.* each for 9-foot ties. Large imports used to be brought in from Baltic and Canadian sources, the 1913 aggregate being 9,836 loads, valued at £32,000. Spruce and Scotch pine are also used principally for building timber, such as joists, studding, sills, etc, and if sound are worth 15*s.* to 20*s.* per ton in the wood. Heavy timber for building and dock work is imported in large quantities, and considerable amounts are creosoted after arrival by the two Dublin and one Waterford creosoting plants.

The exportation from Ireland of blocks for clog soles has always been a substantial trade. Originally alder was used, but birch and beech are superseding it, and the value of wood for this purpose is 10*s.* to 13*s.* per ton in the log. Bobbins are made from beech, birch, or sycamore, obtainable at 6*s.* 2*d.* to 9*s.* 2*d.* per ton. Butter barrels (kiels) are of beech staves, and the wood costs 10*s.* to 13*s.* per ton. Aspen from Russia has been used in certain of the Dublin match factories, but Irish poplar has now taken its place.

For furniture-making, aside from osiers, oak, ash, sycamore, and beech, are used, at prices varying widely with their quality, but in general at rising costs. For telegraph poles, apart from imports, Irish larch and pine are available. The General Post Office is anxious to promote the use of these home-grown poles, and some official encouragement has been given with this end in view. The lengths required range from 22 to 40 ft., and the top diameters from 5 to 10 in. Except in sheltered positions, the larch in Ireland is apt to be curved at the base, owing to the strong and continual winds, and is thus unsuited for telegraph poles.

THE VEGETABLE WOOL OF ECUADOR.

Kapok, known in Ecuador as "lana de ceiba," or vegetable wool, is a product of the largest tree that grows in the forests of the littoral, a species of the genus Eriodendron (allied to the cotton plant). The ceiba bears most of its branches near the top, and the appearance of its bright yellow flowers marks the approaching end of the rainless season. After the flowers fade the pods that yield the kapok of commerce are formed: these are gathered and the fibre extracted by hand. Too early rains interfere with pollenation, resulting in many empty pods, when the natives refuse to devote much time to gathering the crop.

The tree may be grown in Ecuador up to an altitude of 5,000 ft. above sea level, the growth during the first year being about 25 ft. When two years old, on an average it will produce 100 to 200 pods, which contain 1 to 2 lb. of kapok; at five years, 200 to 300 pods, with 2 to 3 lb.; at six years, 300 to 400 pods, with 3 to 4 lb.; at ten years, 800 to 1,200 pods, with 10 to 20 lb. Two hundred pounds of kapok were obtained from one old tree. However, the tree is not cultivated in Ecuador.

From a recent report by the United States Consul-General at Guayaquil it appears that 100 lb. of crude material yield, after cleaning, 45 lb. of first grade kapok, 20 lb. of second grade, and 30 lb. of seed. The seeds must be carefully separated from the fibre, as the presence of oil in them (about 25 per cent.) will produce a stain which renders the fibre unfit for use. The

machine employed resembles a cotton-gin, and does no injury to the fibre or seed. To be marketable the fibre must be long and bright, free from seed and other *débris*, and not too tightly packed in bales of about 100 lb.

There were exported from Ecuador 162,341 lb. of kapok in 1914, 129,226 lb. in 1913, and 135,719 lb. in 1912. Of the seeds, Liverpool received 29,566 lb. in 1914, 84,531 lb. in 1913, and 183,744 lb. in 1912 for their oil. (After the oil has been extracted the residue is pressed into cakes for cattle feed.) First grade kapok sold in 1913 and 1914 for 6*d*. per lb., and second grade for 2¼*d*. f.o.b. Guayaquil, all of the latter being shipped to Peru and Chile. The seeds sold for 3*s*. 8*d*. per 100 lb. net.

In similar tracts of country there exists another but much smaller plant called "flor de seda," or silk flower, also a rapid grower. The product resembles kapok, but is much superior in all textile qualities, as it is finer and more brilliant. It is locally used in the manufacture of mattresses, not being separated in the local market from kapok. Silk flower has great future commercial and industrial possibilities, and, in the opinion of the Consul-General, would well repay scientific investigation and experiment.

EXPORT OF DESICCATED VEGETABLES FROM DENMARK.

Of late years an important trade in the export of desiccated vegetables, especially cabbages, was established in Denmark.

From its geographical position, between the North Sea and Baltic, as well as its proximity to the place of production, Copenhagen is particularly well situated for supplying the chief Scandinavian, Russian, Finnish, and even the British ports, with this article of food.

During the winter months huge piles of dried cabbages, carefully packed in sacks, used to be seen on the quays of the Danish capital awaiting shipment. The greater part of these stocks were sent to the Russian ports of Riga, Libau, Windau, or Reval, from whence they were forwarded by rail to Petrograd, Moscow, and the principal towns in the interior. The quality most in demand for the Russian market is the "Amac cabbage," a kind largely used throughout the empire for the preparation of "Bozschish" and other national dishes.

Amac, or Amager in Danish, is a small island, forming part of the city of Copenhagen, to which it is united by several bridges. It is inhabited by a colony of Dutch peasants, brought from Holland some five hundred years ago, by King Christian II., in order to introduce the Dutch methods of cultivation into Denmark. They still speak a Dutch dialect, and many of the women wear the picturesque national costumes of their mother country.

The Amager cabbage is small, close-leaved, and very compact. It is estimated that upwards of 10,000 tons of this vegetable were exported every year from Copenhagen, besides considerable quantities of potatoes, carrots, celery, and other vegetables.

The cabbages are desiccated in order to reduce their weight by $\frac{9}{10}$, and so save expense of transport, customs duty, etc. The dried vegetable also is not injured by frost, an important matter in northern climates.

ARTS AND CRAFTS.

The London Fair.—The London Fair and Market followed so closely on the British Industries Fair that it was not to be expected that it would contain a great deal that was new. It claimed, of course, to include foreign as well as English goods, but in the present state of affairs it was clearly improbable that many overseas firms would exhibit. Had the management been able to carry out their original intention, the exhibition would have been considerably strengthened by the inclusion of jewellery, silverware, and other metal work; but as Government did not allow this, the scope of the exhibits was practically the same as at South Kensington, save for the omission of the pottery and glass section, though a good many individual manufacturers exhibited at one or other of the fairs, but not at both. What struck the visitor to the Agricultural Hall, as soon as he emerged from the entrance hall, was how much better a building of this type was adapted to the needs of a show of this kind than the Victoria and Albert Museum. It was far easier to see the exhibits properly at Islington than it had been at South Kensington. The only thing one regretted was that fuller use had not been made of the space, and that there was no collection of posters and other large printed work. Amongst the toys the collapsible dolls' houses, etc., of the Armageddon Game and Toy Co. were attractive as well as ingenious, the swans of the Avon Toy Co. had a certain air of distinction, and the tin toys of Burnett, of Birmingham, were artistically a good deal better than such things are wont to be. The hand-painted dolls' furniture of the Olanda Toy Works, Amsterdam, was fresh, and had just that touch of interest which comes of its difference from English work of somewhat the same type. The metal jardinières, vases, and the like exhibited by several firms were very much on German lines. Had one seen them in Milan before the war, one would have deplored the influx of German goods into Italy; but the examples shown by Messrs. Soutter & Sons, of Birmingham, indicated some desire to strike out in a new and better direction. In the stationery section, the cards of Messrs. Ritchie & Sons, of Edinburgh, included some successful pieces of colour work; Messrs. Ibbotson's fancy papers for boxes and bookbinding were interesting, and the chalks and crayons shown by Binney and Smith, of Letch-

worth, had a quality and strength of colour which ought to have drawn attention to them even had they been less skilfully exhibited. As it was, the notices chalked up on brown paper helped the stand considerably.

Lettering and Design in Secondary Schools.—The exhibition of the Royal Drawing Society is always interesting as showing what kind of work is being done by the pupils of a number of secondary schools throughout the country. The fact that it has this year been housed in the Guildhall Art Gallery has naturally rather added to its importance. This makes it all the more to be regretted that, excellent as some of the drawing and painting is, the exhibits connected with arts and crafts do not come up to a higher level. No one who understands the conditions expects a very great deal in the way of design from school girls and boys; but many of the exhibits at the Guildhall are by students of from sixteen to nineteen years of age, and it ought to be possible to teach them a good simple alphabet which they can use and adapt when they want to set out notices or make a cover for the school magazine. Lettering is a simple branch of art craftsmanship which enters into almost every department of life, scientific as well as artistic, and a little training at school would not only be of real use to the girls later in life, but would help to direct them towards the appreciation of beauty in simple everyday things, to prefer a good printed page to a bad one, for example, and would save their friends from the unnecessarily ugly lettering which disfigures not only scientific and other note-books, but would-be artistic calendars and cards. Again, though no one nowadays wants to fetter the imagination of the youthful student, it is possible to teach him, or, at any rate, to lead him, to see that if he is designing a book cover, for instance, there are certain laws or principles which, if he follows them, will help his design, and if he ignores them will at the least mar its success. Proportion, balance, fitness are not mere conventions invented to embarrass the budding designer; they are in their way as natural as the laws of growth. The schools, of course, have hard work to teach all that is required of them, and even an art mistress or master does not necessarily understand much about design, but it looks as though if the subject is to be taught at all, it should have rather more thought bestowed upon it than is at present the case.

CORRESPONDENCE.

"OLD MASTER" POSTCARDS.

On page 378 of the Society's *Journal* of March 24th, you criticise certain postcards after the Old Masters shown by the Medici Society at the British Industries Fair. You further refer to certain other postcards issued by "a firm in Milan (whose name suggests a possible German origin) . . . It is true that [its] later productions are not (or were not before the war) quite as successful as the earlier ones." You further remark that the "ideal coloured postcard" will needs combine "the qualities of the English and Milanese cards."

I do not know how far the minor history of minor printing may interest you, but there hangs a tale by your story.

Hans Hoesch of Milan began, somewhere about the years 1900-2, to issue the postcards of which you speak. He also produced what, in 1906-8, became Nos. 1-7 of the Medici Prints, a series now numbering nearly 250 subjects.

Hans Hoesch was a German-Italian. His father had, sometime, worked for a big Viennese firm of collotypers. He was a genius, but genius and balance are not always synonymous. About 1902-5 I purchased various prints from him. Finding that the quality was maintained, and being entirely unable to comprehend—a failure shared by many practical painters here—how Hoesch got this quality at all, much less got it at the price, I, in 1906, went out to see him. In those days, my ignorance of collotype and "Old Masters" was equal. I gave Hoesch orders such as his soul had never dreamed of, and returned home.

Furnished with cash, the defects of his qualities overcame Hoesch. I need not relate the sorry tale. The courts intervened and Hans was long since forbidden even to enter the family "stabilimento." The more recently issued publications, postcards or otherwise, of the Hoesch works bear the name of his brother. Not every family breeds two geniuses in one generation. Hans was, in his way, a great master. His brother is not so.

You desiderate a combination of the Milanese and English card, and I will take it that by "Milanese" you mean the product of Hans.

But you speak of "Old Master" postcards. Such, it is to be presumed, should attempt to "reproduce" the original picture. Did Hans Hoesch so do? Not he! Hans was a supreme master in the art of suggestion. Neither in drawing nor in colour did his products necessarily resemble the paintings reproduced. He translated them into terms of "five-colour collotype." The product, a combination of Hans Hoesch and Leonardo, is a miracle of translation, but no more a reproduction of Leonardo than is a certain picture, in the Brera, by Cesare da Cesto an equivalent of the "Madonna of the Rocks."

Apart from the genius of Hans Hoesch, his cards were printed in collotype, and irresponsibly printed at that. Never did five out of a hundred agree in colour. And as for the 1914 versions, when Hans had been excluded from the firm these three or four years, by decree of the courts, between them and the worst impression of 1906 was a great gulf fixed.

The Medici cards are reproduced by mere four-

colour process. They show the miserable "screen." They pretend to be reproductions, and are to be judged as such.

The Medici postcard is, though I say it, a first-class commercial product, capable of daily repetition *ad infinitum.*

Before Hans Hoesch's postcards—not the inferior products of the firm since he left it—I have for ten years been humbled. He once offered to sell them to me wholesale at 60 lire per 1,000. Being offered a trial order for 10,000 he declined it. Even in a one-man works in the outskirts of Milan, before the Tripoli war, the price was incredible. I have never seen how to produce them at £4 per 1,000, works cost, and even so they could not be reproductions, nor could any standard be observed in the run. Hans Hoesch, more than once, all but made me a bankrupt. But, I repeat, Hans was of the race of "Great Masters."

PHILIP LEE-WARNER.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

MAY 3.—

MAY 10.—SIR FRANCIS TAYLOR PIGGOTT, M.A., LL.M., Chief Justice of Hong-Kong, 1905–1912, "Neutral Merchants and the Rights of War." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

MAY 17.—GEORGE PERCIVAL BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe." SIR WILLIAM MARTIN CONWAY, M.A., F.S.A., F.R.G.S., will preside.

MAY 24.—JOHN COLLETT MOULDEN, A.R.S.M., M.Inst.M.M., "Zinc, its Production and Industrial Applications." (Peter Le Neve Foster Prize Essay.)

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

APRIL 27.—JAMES MACKENNA, M.A., I.C.S. (Deputy Commissioner, Myaungmya, Burma, and designated Agricultural Adviser to the Government of India), "Scientific Agriculture in India." The paper will be read by Sir Steyning W. Edgerley, K.C.S.I., K.C.V.O., C.I.E., Chairman of the Indian Section. SIR ROBERT W. CARLYLE, K.C.S.I., C.I.E., will preside.

MAY 18.—SARDAR DALJIT SINGH, C.S.I., "The Sikhs."

JUNE 1.—PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India." THE RIGHT HON. LORD ISLINGTON, G.C.M.G., will preside.

COLONIAL SECTION.

Tuesday afternoon, at 4.30 p.m.:—

MAY 2. — THE RIGHT HON. SIR WILLIAM MACGREGOR, G.C.M.G, C.B., LL.D., D.Sc., "Some Native Potentates and Colleagues." THE RIGHT HON. VISCOUNT BRYCE, O.M., D.C.L., LL.D., F.R.S., will preside.

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m.:—

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

Syllabus.

LECTURE I.—MAY 1.—*Periodic Motions.* Definitions and modes of production—Stable and unstable equilibrium — Inertia, gravity, and elasticity — Pendulums and spring oscillators of various kinds —Torsional vibrations, balance wheel—Corrugation of rails—Musical instruments—Complex vibrations and the quality of a tone—Vibrations on large scale, seismic tremors, vibrations of ships and buildings, lightning.

LECTURE II.—MAY 8.—*Waves in Ponderable Matter.* Transverse and longitudinal waves in solids and liquids — Methods of production and propagation — Polarisation — Wind waves — Ship waves—Tides and seiches—Cloud waves—Independence of wave trains—Superposition of harmonic motions—Sound waves—Submarine bells—Voice, phonograph, and gramophone.

LECTURE III.—MAY 15.—*Waves in the Ether.* Free and conducted—Light, heat, and electric waves — Alternating currents — Telephonic transmission—Wireless telegraphy—Submarine cables —Inductance, capacity, and resistance—Limits of known wave-lengths—Röntgen rays—Light—Heat —Reflection, refraction, and diffraction of wave motions—Stationary waves—Attenuation and distortion of travelling waves.

LECTURE IV.—MAY 22.—*Resonance.* Mechanical and electrical—Superposition of periodic impulses—Universal importance of the selective absorption of wave motions—Mechanical resonance or revibration — Screening of vibrations, absorption, and filtration — The acoustics of buildings — Sound resonators—Absorption of light waves—Coloured glass — Vision and photography — Absorption of electrical power by resonance—Tuning in telegraphy.

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FRIDAY, APRIL 28, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MAY 1st, 4.30 p.m. (Cantor Lecture.) J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." (Lecture I.)

TUESDAY, MAY 2nd, 4.30 p.m. (Colonial Section.) THE RIGHT HON. SIR WILLIAM MACGREGOR, G.C.M.G., C.B., LL.D., D.Sc., "Some Native Potentates and Colleagues." THE RIGHT HON. VISCOUNT BRYCE, O.M., D.C.L., LL.D., F.R.S., will preside.

WEDNESDAY, MAY 3rd, 4.30 p.m. (Ordinary Meeting.) SIR HENRY HARDINGE CUNYNGHAME, K.C.B., Member of the Royal Commission on Food Supplies, 1905, "Supply of Food in Time of War."

Further particulars of the Society's meetings will be found at the end of this number.

INDIAN SECTION.

Thursday afternoon, April 27th, 4.30 p.m.; SIR ROBERT W. CARLYLE, K.C.S.I., C.I.E., Member of the Council of the Governor-General of India, 1910–1915, in the chair. A paper on "Scientific Agriculture in India," by JAMES MACKENNA, M.A., I.C.S., Agricultural Adviser to the Government of India, was read, in the absence of the author, by Sir Steyning William Edgerley, K.C.S.I., K.C.V.O., C.I.E., Chairman of the Indian Section.

The paper and discussion will be published in subsequent numbers of the *Journal*.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on April 11th, 1916; THE RIGHT HON. SIR WILLIAM MACGREGOR, G.C.M.G., C.B., LL.D., D.Sc., in the chair.

THE CHAIRMAN, in expressing his pleasure at occupying the chair, said he felt himself under very great obligation both to Newfoundland and to Sir Daniel Morris. During his term of office in Newfoundland there were several matters of very great interest, including the ancient question with respect to the French shore, and the establishment of the great pulp manufactory at Grand Falls, one of the finest establishments of the kind in existence, created by the energy and enterprise of Lord Northcliffe. He had also been greatly assisted by Sir Daniel Morris in 1879 in Fiji, where there was an outbreak of coffee-leaf disease, which at that time was practically new to the scientific world. The writings of Sir Daniel Morris, who had thoroughly investigated the subject, were a great help in dealing with the disease.

The paper read was—

THE FOREST RESOURCES OF NEWFOUNDLAND.

By SIR DANIEL MORRIS, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S.

Two years ago the Prime Minister of Newfoundland, when on a visit to this country, said: "Even to-day Newfoundland is not in the public eye, and it is only occasionally that attention is drawn to its valuable resources and its great possibilities in the future." Very few people probably know that Newfoundland is 11,000 square miles larger than Ireland, only one-fifth smaller than Great Britain, three times the size of Holland, twice as large as Denmark, equal in size to three maritime provinces of Canada and about the size of the State of New York. "In addition to its great cod fisheries, the largest in the world, and its rich minerals, it has forests of spruce and other timber now

producing the pulp and paper upon which many of the London and some of the New York papers are being printed, and over three million acres of good agricultural land as yet practically untouched."

It is, I believe, twenty-three years since Newfoundland has formed the subject of a paper read before the Royal Society of Arts. After so long a period, I trust it will not be regarded as presumptuous on my part to propose to lay before you in this war time a brief summary of facts and figures that have been brought together relating to the forest resources of this oldest and the nearest portion of our Overseas Empire.

Perhaps one of the paradoxes of the war was that Newfoundland at the end of 1915 found itself more prosperous than ever in her history, despite the unfavourable circumstances that had operated just before the war and during the first few months of its progress. The fisheries were successful, and prices rose to almost double what they were in 1914. An estimate given in the *Times* mentioned that in the 1915 season's codding operations Newfoundland realised two million dollars more than in 1914. Further, operations connected with iron mining were greatly increased owing to the demand for iron and steel for munition-making in Canada. Similarly pulp and paper companies which had had to face adverse conditions at the outset of the war "have been operating in full blast." In addition, as will be shown later, a new industry has grown up in Newfoundland in 1915 for the production of pit-wood for colliery purposes, owing to the blockade of the Baltic and the inability to obtain supplies as formerly from Russia and Sweden. It is satisfactory to learn that this condition of affairs has been brought about although the Colony has 3,200 men engaged in the war—serving in the Naval Reserve and in the Newfoundland Regiment.

As regards accessibility Newfoundland is well placed. From this country a man leaves Liverpool on Saturday by the Allan or Furness Line and arrives at St. John's, the capital, on the following Saturday. From New York he can travel in a Pullman sleeping-car and in forty-eight hours he can be at a salmon pool in Codroy Valley and find splendid sport. Yachting and scenery are unequalled in any other part of the world.

Newfoundland offers special attractions to tourists and health seekers, and it is claimed to be a paradise for sportsmen. Of the large game the caribou stands foremost; but there are also bears, wolves and lynxes; fur-bearing animals such as foxes, otters, marten, minks, musk-rats and rabbits. Of birds there are willow grouse, partridge, Canadian goose, many varieties of duck, snipe, woodcock and plover. For the rod there is salmon and trout fishing. The writings of Selous, Hesketh Pritchard, J. G. Millais, Dugmore and Admiral Kennedy all bear ample testimony to the excellent sport and splendid scenery of Newfoundland.

Mr. Alexander Murray, C.M.G., for sixteen years Geologist to the Government, writes: "The climate of Newfoundland is, as compared with the neighbouring continent, a moderately temperate one. The heat is far less intense, on an average, during the summer than in any part of Canada, and the extreme cold of winter is much less severe. The thermometer rarely indicates higher than 70° F. in the former, or much below zero in the latter. The climate is undoubtedly a very healthy one, and the general physique of the natives, who are a powerfully-built, robust and hardy race, is a good example of its influence."

The island is occupied entirely by a white English-speaking element, of which 97·5 per cent. is native-born. There are no aborigines. The people, numbering 243,000, are law-abiding, industrious and temperate.

A useful summary of information respecting the forest resources of Newfoundland is contained in "Newfoundland in 1911," by Mr. P. T. T. McGarth, with a Foreword by the Premier, the Right Hon. Sir Edward Morris. Possibly a still more comprehensive store of facts and figures is contained in the Report of the Dominions Royal Commission, especially the Minutes of Evidence taken in Newfoundland in 1914 presented to Parliament in May, 1915 (Cd. 7898).

Physical Features.

As the map shows, the island is irregular in shape, with the general outline of a triangle. Its greatest length is over 300 miles and its total area 46,000 square miles. Its triangular extremities are Cape Norman on the north, marking the entrance to Belle Isle Strait, Cape Race on the south-east, one of the world's greatest seaboard outposts, and Cape Ray at its south-west, the chief landmark of the Gulf of Lawrence route. All along the coast are innumerable bays and harbours.

Perhaps the most striking physical features of the coast are the several peninsulas which jut out from the main structure. There is the Avalon peninsula on the eastern coast, which is almost

another island—the isthmus between Trinity and Placentia Bays being only three miles wide; and there is Burin peninsula between Placentia and Fortune Bays. On the west coast there is Port-au-port peninsula with the great northern peninsula, formerly called by the French the Petit Nord, and more recently known as the St. Barbe peninsula. The general surface of Newfoundland is hilly, but no marked elevations are reached. The mountain ranges extend north and south; the principal is the Long Range Mountain, which begins at Cape Ray and continues north-east for 200 miles. Its highest peak is 2,000 ft. There are several lesser ranges with peaks from 1,000 ft. to 1,730 ft.

The geology of the island presents numerous points of interest. The rocks range from the Laurentian to the Carboniferous, and are those in which most of the world's metallic wealth occurs.

Inlets, Rivers, and Lakes.

Newfoundland has an immense number of inlets along the coast. As a result, no portion of the island is more than sixty miles from the sea. There are also numerous rivers. The longest is the Exploits River—200 miles long—which drains an area of 4,000 square miles and is navigable for thirty miles; the Gander, 100 miles long, and its tributaries drain a similar area. Both flow in a northerly direction. The Gambo and Terra Nova flow in an easterly direction into Bonavista Bay. On the west the principal river is the Humber, 80 miles long. This passes through a picturesque and well-wooded country. Along the south coast the rivers are smaller owing to the configuration of the country, but they are numerous and easily accessible. In addition, there are large inland bodies of water, such as the Grand Lake, covering 200 square miles; the Red Indian Lake, 67 square miles; the Deer Lake, Gander, Gambo, Terra Nova, and George IV. lakes. Further, there are dispersed all over the country lesser bodies of water locally termed "ponds."

Water Power.

As may be gathered from the above, Newfoundland is singularly well supplied with facilities for coasting and river traffic, and is a remarkably well-watered country. Water power is available in numerous localities, and the Government offers leases on favourable terms.

"Leases are granted by Government for terms of years of the right to use the waters of any river for driving machinery subject to such rent and conditions as the Crown may prescribe and to the preservation of the vested rights of all persons holding lands whose interests may be affected by the use of such water with a fine of $100 per each offence for introducing sawdust or other deleterious matter into such water." The Royal Commission sums up the situation by stating that "Newfoundland shares with Canada the advantage of great potential water power."

Trade.

As regards trade it is sometimes said that Newfoundland exports all that it produces and imports all that it consumes, but according to the report of the Royal Commission this statement, like many other generalisations, does not stand the test of statistical examination. The total external trade per head of population is £25 5*s.* as compared with £29 7*s.* for Canada, and £9 9*s.* for the United States, so that the external trade of Newfoundland per head is nearly as great as that of Canada and three times that of the United States.

It is probable that the main lines of development in Newfoundland will continue to be associated with the three principal industries that have already occupied chief attention—viz., the fisheries, the mines, and the forests.

In regard to the fisheries, these have generally contributed nearly 80 per cent. of the total exports. The cod fisheries of Newfoundland are the largest in the world. A million and a half hundredweight of dried codfish is exported in addition to large quantities of herrings and lobsters, cod oil, seal oil, seal skins, and whale oil.

The mineral wealth is regarded as very considerable. The deposits of hematite iron at Bell Island are reported by the Royal Commission to be "remarkable." It is said there is nothing at all comparable to them in any of the other Dominions "except, perhaps, those at Iron Knob and Iron Monarch in South Australia." Further, it is possible they may become of "immense potential importance to the iron and steel industries of the Mother Country as well as those of Canada."

For transport purposes, in addition to the facilities afforded by the numerous inlets, rivers, and lakes, there are railways with a total mileage of 800 miles. Associated with these is a flotilla of eight steamers. By means of the agency of the railroad and the coasting steamers, it is claimed that the trading conditions of the island are being steadily extended and improved.

Forest Areas.

The timbered areas are generally found in the valleys of the larger rivers and their tributaries, and on the banks of the lakes and ponds,

confined, in many cases, to strips from one to two miles wide. It is estimated that there are altogether about 10,000 square miles (6,500,000 acres) of wooded lands in the Colony. The best timbered areas on the rivers and water-courses draining the east coast are on the Gander River, Dog Bay Waters, Indian Arm, Exploits River and its lakes and tributaries, the Halls Bay Waters and the rivers flowing into the south side of White Bay and into Baie Verte. Those on the west coast are associated with the Grand Lake Waters, Deer Lake, Humber River, and others flowing into Bay of St. George and into Bay St. John, Bonne Bay, and Hawke's Bay. On the south coast there are many areas of timbered country at the bottom of the bays and along the lower reaches of the rivers. In some sections very considerable areas of large timber and large quantities of trees suitable for pulp wood still remain.

All the known timbered areas in Newfoundland, except those lying within the three-mile limit of the shore reserved by the Government, are held under licence by private parties or by companies. The conditions under which these licences are issued give the holder the right to cut timbers on lands described therein for a term of ninety-nine years on the payment of an annual rental at the rate of $2 per square mile.

In the case of lumber there is a royalty of 50 cents per M. feet B.M., payable on all timber cut on the area except such timber as is manufactured into pulp and paper, which is not subject to a royalty.

In the production of sawn or manufactured lumber there are a dozen large mills in operation under licence, and 120 small mills which produce cooperage stock, barrels, shingles, and laths. The annual value of the output of these is estimated at £120,000. In 1906–7 the value of the exports of sawn lumber reached a total of £65,000; but in later years the value has fallen to less than £1,200. One explanation of this is the increased quantity of lumber absorbed by local requirements. In spite of this, a considerable quantity of hard pine and other woods, not obtainable in the Colony for inside parts of buildings, furniture and carriage building, is imported. The value of these in 1912–13 amounted to £21,000.

Of the spruce lumber, which is of exceptional quality, Mr. Turner, Deputy Minister of Agriculture, reports that it is used locally for general building purposes, and for ship and boat building, or, in the case of the smaller fir and spruce, is manufactured into pulp. A very small proportion of the birch timber is utilised; the principal uses at present are for the construction of the under-water parts of the hulls of schooners and for wharf piles, as the wood is found to last better than most for these purposes; it is also used for sheaves for rollers, for carrying haulage cables at the Bell Island Iron Mines, spools for paper, and laths for binding pulp for export at Grand and Bishop's Falls, and some for car building and furniture. One mill at Bay d'Espoir uses a large proportion of its cut of birch as well as spruce and fir for the manufacture of furniture, while the factories in St. John's use a considerable quantity for this purpose. Tamarack and juniper are used for schooner construction and for flooring in buildings. In addition to the timber manufactured, as before mentioned, a very large quantity is cut annually and used for firewood, fencing, poles for erecting fish flakes, spars for boats and vessels, telegraph poles, railway ties, pit props, wharf piles, etc. As no return of the timber used for these purposes is made it is not possible to give the quantity, but, according to Mr. Turner, it is probably as great or greater than the quantity used in the mills.

Labrador.—The peninsula of Labrador, with its 600 miles of coast and 120,000 square miles of territory, is a dependency of Newfoundland. The boundary between Labrador and Canada is a line running due north and south from Blanc Sablon in the Strait of Belle Isle to latitude 52° N. Newfoundland, therefore, owns the outlets to the Atlantic of all the large areas drained by Sandwich Bay and Hamilton Inlet, and the lesser fiords that indent the coast.

Recent explorations by competent observers, and the writings of Dr. W. T. Grenfell and others, show that much of Labrador is not a country of "awful desolation," but in many parts well wooded and containing latent resources of value in forests, fisheries and minerals. The timber trees, very similar to those of Newfoundland, consist of white and black spruce, balsam fir and larch, the Jack or Banksian pine, cedar, white birch, poplar and aspen. The forest areas are reported to be almost continuous over the southern portions to 53° N. As our Chairman, when Governor of Newfoundland, explored some parts of Labrador in the summers of 1906 and 1908, he is well qualified to speak as to the resources and prospects of the country.

It is generally recognised in Newfoundland that Labrador may eventually become the

centre of a large wood-pulp industry. In the meantime it might supply pulp wood to some of the mills operating in Newfoundland.

Timber Trees.

The pine or white pine of Newfoundland (*Pinus strobus*) is known in England as the Weymouth pine, as it was introduced in 1705 by Lord Weymouth. It is a fairly common ornamental tree in parks and gardens in this country. On account of the value of its timber, for a century or more it has played a conspicuous part in the material development of the United States and Canada. It is the more generally useful of all the pines. As the supply is falling off, prices for white and yellow pine of good quality have considerably risen in recent years. In Newfoundland it is stated that "in some sections, notably on the Gambo, Gander, and Exploits Rivers, and at Dog Bay, good pine is still to be found." In other districts the trees are more scattered. The sawn lumber produced from the white pine, with some spruce, is estimated to reach an annual value of £200,000. Most of it is devoted to local purposes. It has been very little exported in recent years. *Pinus strobus* is not used for pulp purposes. The red pine (*Pinus resinosa*), which somewhat resembles the Corsican pine in this country, grows fairly plentifully in Newfoundland, and is largely used in the construction of vehicles and for household furniture. On account of the resinous character of the timber, it furnishes an excellent material for railway ties.

The black spruce (*Picea nigra*) is widely distributed in Eastern America and Canada, and forms an appreciable proportion of the timber trees of Newfoundland and Labrador. The superintendent of the Grand Falls Mills, in a memorandum prepared for the Dominions Royal Commission, speaks of the black spruce as affording "the best material for pulp-making there is." This is supported by Mr. Reuben F. Horwood, managing director of the Horwood Lumber Company and of the pulp mills at Campbellton, who says: "Newfoundland spruce makes wood pulp equal to the best, and superior to most on the market, and it bears a high reputation."

After six years' experience at the Grand Falls Mills the superintendent supplies the following further information: "Black spruce gives a long and strong fibre. The smoothness of the fibre gives the paper a good finished surface. As the tree grows comparatively slowly, the wood is very solid and heavy—about 30 lb. per cubic foot bone-dry weight—giving a large yield of pulp. This reaches about 2,200 lb. of ground wood pulp and about 1,200 lb. of bone-dry sulphite pulp each per cord of wood." The wood of the black spruce contains more resin than the wood of the balsam fir, and is slightly darker in colour.

The balsam fir (*Abies balsamea*) derives its name from the transparent balsamic resin yielded by it. This is known as Balm of Gilead and Canadian balsam. The tree is very abundant in the central and northern districts of Newfoundland. At the Grand Falls Mills it is stated that possibly more than one-half of the pulpwood used there is balsam fir. There is no record what proportion is used at the Bishop's Falls and the Campbellton Mills. The superintendent at Grand Falls furnished the Royal Commission with the following summary of the results with balsam fir: "Balsam fir gives a fibre a good deal shorter and weaker than the black spruce. The fibres are not so smooth as the fibres of the black spruce, and it is difficult to obtain a good finished surface on paper made entirely from balsam fir pulp; but these trees grow very rapidly—often twice as fast as the black spruce—which tends to make the wood soft and spongy, especially when the trees grow large. The wood is light (weighs about 24 lb. per cubic foot bone-dry weight), and consequently gives a smaller yield of pulp, viz., about 1,850 lb. of ground wood-pulp, and about 1,000 lb. of bone-dry sulphite pulp each per cord of wood." An important point in using balsam fir is that the utmost care must be taken when removing the bark to see that none is left, for most of the resinous matters in this species are concentrated in the bark. If used all by itself in the manufacture of sulphite pulp it gives a comparatively good yield, and only requires a weak acid. The pulp is whiter but not so strong. The balsam fir was for a long time considered by American and Canadian mill-managers to be of little value for pulp-making. It is only within the last ten years it has been so largely used.

The white spruce (*Picea alba*), although fairly abundant in Newfoundland, is not specifically mentioned as being utilised for pulp purposes. It is easily distinguished from other spruces by its bluish disagreeably smelling leaves. It is said that in northern Quebec only the tops of the white spruce are converted into pulp, the trunk being used for sawn lumber and for railway ties, piles and telegraph posts. The American larch, commonly known as the tamarack (*Larix*

americana), thrives in certain areas in Newfoundland. Tamarack and juniper are reported to be used for schooner construction and for flooring buildings. The tree vegetation of Newfoundland, in addition to the above, includes a large number of broad-leaved trees, some of which may also be utilised for making wood pulp. Among birches the canoe or white or paper birch (*Betula papyrifera*) grows to a good height. The wood is light, strong, tough and close-grained. The heart wood is tinged with red. The yellow birch (*B. lutea*) is another strong-growing tree, with close-grained, satiny timber largely used in the manufacture of furniture. The cherry birch (*B. lenta*), also known as the black, sweet, and mahogany birch, produces a heavy, very strong and hard wood extensively used in the manufacture of furniture. With regard to a wider utilisation of birch timber in Newfoundland, the Deputy Minister of Agriculture suggests the establishment of "factories for making such articles as flooring, bobbin stock, bobbins, spools, shoe shanks, staves, veneer, dowels, chairs and furniture stock, piano backs and other articles, into all of which this wood is manufactured in other countries." "Such factories," he says, "would not require very large powers to operate, and there are many localities in which water power might be developed, which, while not sufficient for the operation of large plants, such as those required in paper and pulp factories, would be sufficient for the running of the machines used for making these articles."

The sugar maple (*Acer saccharum*) is found in Southern Newfoundland. In addition to the sugar produced from the sap, it is of great economic importance on account of its splendid timber, which is strong, close-grained, and polishes well. Timber with curled and contorted grain is known as "Bird's-eye" maple, and is used for cabinet work.

The black ash (*Fraxinus sambucifolia*) grows to a large size in swamps and along the banks of rivers in Southern Newfoundland; the rather coarse-grained wood is durable, and is used for a variety of purposes.

The American elm (*Ulmus americana*) is also present as a large tree in Newfoundland. It yields a heavy tough timber, which is used for wheel sticks, in cooperage and boat- and ship-building. The balsam poplar, or tacmahac, and the aspen or quaking poplar yield light timber, which may be used to some extent for wood-pulp purposes, as in Canada.

According to Mr. S. Charles Phillips, in the manufacture of paper pulp, Canada, in 1914, used 1,224,376 cords of wood. Of this 68 per cent. was spruce, 25 per cent. balsam fir, 3 per cent. hemlock, and nearly 2 per cent. Jack pine (*P. Banksiana*)—the balance being poplar.

Wood Pulp.

In botanical literature we continually come across the term cellulose. This applies to one of the main constituents in the structure of all plants, namely, that which forms the casing or wall of the different cells. In fact, it forms what may be called the woody portion of the plant, and constitutes the skeleton of all vegetable fibres. One of the most familiar forms of cellulose is cotton fibre. As pointed out by Mr. C. F. Cross, the applications of cellulose to the necessities of human life are as infinitely varied as they are colossal in magnitude. The utilisation of vegetable fibres in textile industries and in paper are based on the fibrous forms of the naturally-occurring cellulose, which must possess such structural qualities as strength, elasticity and specific gravity. In addition, they must possess the power of resistance to chemical changes to enable them to withstand wear and tear. Staple textiles of this group are cotton, flax, hemp, and jute. Other fibres of a coarser character are used in rope-making and brush-making industries. During the latter part of the nineteenth century the progress made in the use of various forms of cellulose has been almost phenomenal. Taking one industry, that of paper, which formerly was almost entirely made from rags either linen or cotton, owing to the insufficient supply of rags and the consequent rise in price, other fibres began to be adopted as substitutes. Mainly through the persevering efforts of Mr. Thomas Routledge in the seventies, esparto grass from North Africa was utilised for paper-making, and the success of this is shown by an annual consumption of something like 250,000 tons. Most kinds of straw are also capable of being used for paper-making. It closely resembles esparto, and is reduced to pulp by a somewhat similar process. During the period from 1870 to 1880 a still greater advance was made, as it was demonstrated that cellulose well adapted for paper-making could be obtained from the timber of coniferous trees. These trees, as is well known, are widely distributed all over the world. The development in this direction has been so great that wood pulp now furnishes the main source of supply for paper-making. The total value in 1912 of raw materials imported into this country for paper-making

was £5,800,000; of this wood pulps represented 70 or 80 per cent.

Mr. Cross, in a recent article in *Nature*, states that wood pulps are so largely adopted for paper-making, not only on account of their quality or merits as cellulose, but being obtained from a massive material they are capable of being produced in a state of exceptional cleanliness and by economical processes. Moreover, as the paper-maker found himself provided with a "half stuff" clean, cheap, and presumably unlimited in quantities, its production displaced the chemical pulping of such raw material as esparto and straw. There is one drawback, but that is inevitable at present—viz., the dependence of the English paper-mills upon foreign supplies. To some extent this can be obviated by tapping the enormous resources of Canada and Newfoundland. Canada is credited with forest areas of 800 million acres, and, under a system of organised forestry, it should eventually be capable of largely meeting the requirements of this country. At present Canada is the second largest producer of wood pulp, the first being the United States of America. As is here shown, Newfoundland, and Labrador also, are likely to provide an appreciable supply, provided their resources are carefully guarded and fully utilised.

Paper and Pulp Mills.

The most important and far-reaching event that has occurred in Newfoundland in recent years has been the establishment of a pulp and paper industry by the Anglo-Newfoundland Development Company, followed soon afterwards by the Albert Reed Company, of London. The Anglo-Newfoundland Development Company, which is known locally as the "A.N.D. Company," determined in 1905 to locate its mills in Newfoundland, after spending three years in seeking an adequate supply of pulp-wood and a suitable site elsewhere. Exhaustive tests of woods in Canada, Sweden, Norway, and other countries where forest growths suitable for the manufacture of pulp and paper are found, were made. The conclusion was reached that Newfoundland was most worthy of consideration, and a self-contained forest area of 3,400 square miles in the centre of the island was secured. This is nearly twice as large as the whole of Prince Edward Island. From the Grand Falls on the Exploits River the company secured the necessary power, with communication from the mills to tide-water at Botwood.

The company gave the following as the reasons that weighed with them in making their decision: That timber is cheap and of excellent fibre; that labour is plentiful, and, compared with the United States and Canada, moderate in price; that the cost of logging is low because of the dense growth of the wood and the general topography of the country, water being abundant and the whole terrain such that the logs can be got to the rivers for driving with a minimum of cost and labour.

The logging operations carried on by the A.N.D. Company are necessarily on a large scale. The felling takes place in winter, when the fishermen find congenial and useful employment on land. The size of the trees used for pulp-wood must not be less than four inches across at the small end. The total yield from each winter cut is about 60 millions superficial feet of timber, equivalent to 120,000 cords of pulp-wood. A cord is a cubical measure (4 ft. × 4 ft. × 8 ft.) containing 128 cubic feet; according to the time it is cut the weight may vary from two to two and a half tons. Usually a ton weight of dry pulp is obtained from each cord. As already stated in the case of the black spruce, a cord of wood gives about 2,200 lb. of dry ground wood pulp, or 1,200 lb. of bone-dry sulphite pulp.

Grand Falls Mills.—These fine mills, owned by the Anglo-Newfoundland Development Company, were completed in the autumn of 1909, when the first paper was made in the Christmas week of that year. During the next two and a half years the mills were run with three paper-making machines, eighteen wood-pulp grinders, and two sulphite-pulp cooking digesters. The output was a daily average of 120 tons of paper. In 1912 additions to the plant were made of two other paper-making machines, six additional grinders, and one extra digester, which provided for a total daily production of news paper averaging 190 to 200 tons per day, and a surplus production of ground wood pulp for export averaging thirty tons per day. The mills at the time of their completion were the largest in the world, and represented the most perfect assemblage of paper-making plant and equipment that engineering skill and experience, backed by ample capital, could provide. They now supply the requirements of four British newspapers. The capital involved is £1,668,653, which includes £490,000 debentures.

The raw material, that is the pulp-wood, is obtained from forest areas held by the company aggregating 3,400 square miles. These areas are on the banks of the Exploits River and its tributaries, reaching in a south-westerly direction as far as King George IV. Lake. They extend to

the north-east to the coast in the Red Indian Lake country. In the logging operations a force of 1,500 men is employed. These are located in eighty camps. In spite of the enormous yearly consumption of pulp-wood the company is satisfied that it possesses "more than an ample supply" for the needs of the present mills.

The whole of the power operating these mills is derived from the Grand Falls. The total height of these from the top of the dam, at the head of the rapids, to the bottom of the power-house is about 120 ft. There is a direct head of water of 113 ft. The power generated is 7,500 h.p. This is sufficient to run all the machinery in the mills, outside of the grinders, which take 16,000 h.p. direct from the water-wheels.

Two Grades of Pulp.

The pulp produced is of two qualities—mechanical pulp and sulphite pulp. The former is produced by forcing the wood logs, after they are cut into short lengths and barked, by hydraulic pressure against the face of a rapidly revolving grindstone, continually flooded with water. The fibres of the wood are torn away by the friction of the stone, and the constant stream of water carries the pulp into a pit below. When fully sieved and screened the pulp is distributed either to the paper-machines for making into news paper, or to the hydraulic presses which squeeze out the water, leaving sheets of pulp with 40 per cent. moisture, in which state it is packed in bales for export.

In the case of sulphite pulp, the prepared logs are chipped by a powerful machine into small pieces or flakes about an inch square and one quarter of an inch thick. These chips are next thoroughly "digested" with a chemical solution (bisulphite of lime) at a high temperature.* By this means the chips are gradually reduced to a soft pulpy mass. The latter is thoroughly washed with clean water and finally sent to the paper-mill. The combination of the two stocks—mechanical and chemical pulp—are put together by the paper-mill and result in the finished product of news paper. The five paper-machines make sheets of various widths from 112 in. to 152 in.

The completed paper having been rolled on reels which are running at the rate of 575 ft. per minute, and properly wrapped and protected for shipment, is conveyed by the company's own railroad to its shipping port at Botwood, and there shipped on chartered steamers to England. The average amount paid in wages and salaries by the company in Newfoundland varies from £175,000 to £180,000 per annum. It speaks well for the adaptability of the Newfoundland people, for the most part fisher-folk, that at the Grand Falls Mills only 1 per cent. of the work-people are from outside the Colony.

In the neighbourhood of the Grand Falls Mills, following the example of the best traditions of British commercial enterprise, the A.N.D. Company has established a town of 2,500 inhabitants. This contains well-built houses and bungalows, a hospital, a good club, bath-rooms, a large school, a town hall which is the centre of all public amusements, and spacious athletic grounds. Outside capital has established itself in stores which supply all requirements. At a distance of three miles a farm supplies the town with milk and vegetables. The head-quarters of the logging operations are at Miller Town, a settlement of about one hundred houses with a church, school, hospital and stores complete.

Bishop Falls Mills.—These are owned by A. E. Reed & Co. (Newfoundland, Ltd.), who are associated with Albert E. Reed & Co., of London. The latter operate eight paper-mills in the south of England. The mills were completed and commenced operations in April, 1911. The area of timber licences held by the company is 820 square miles, situated mostly in the Exploits watershed east of Grand Falls. The water-power derived from the Bishop's Falls has a capacity of 14,000 h.p. The mills equipped for the manufacture of mechanical paper pulp have eighteen grinders capable of yielding 140 dry short tons per twenty-four hours. Most of the production is shipped to England. The number of mill hands is 200, with 450 employed in the woods in winter. The resources of the company in Newfoundland are stated to be ample for all its requirements.

At Campbellton (Indian Arm), in Notre Dame Bay, the Horwood Lumber Company has a pulp-mill, and others are in contemplation.

It was pointed out by Mr. S. Charles Phillips, in his recent paper before this Society, that in 1913, a normal pre-war period, Newfoundland supplied this country with news paper (on reels) to the extent of 17·4 per cent. of the total imports. On the other hand, in 1915, a full year of war, paper on reels showed a total decrease of nearly 30,000 tons—the total imported being 106,720 tons. Of this quantity Newfoundland contributed 44·7 per cent. Thus,

* The lime for the manufacture of sulphite pulp is obtained locally, and is said to be quite pure and suitable for the purpose.

for the first time in the history of the paper trade, Newfoundland took a premier position as an exporter to this country of paper on reels—the total amount being 47,789 tons, or 15,410 tons in excess of those of Norway.

The following figures show the export of paper and of pulp since the industry first began:—

Year.	Paper.		Pulp.	
	Tons.	Value.	Tons.	Value.
		£		£
1910. .	7,900	73,000	6,900	14,000
1911. .	21,100	197,000	27,200	52,000
1912. .	26,800	250,000	42,100	75,000
1913. .	44,400	415,000	57,500	91,000
1914. .	40,077	374,000	51,605	77,645

Pit Timber.

In addition to the production of paper and pulp and certain descriptions of lumber, Newfoundland affords an excellent field of operations for pit timber.

The total annual consumption of pit wood, or pit props, for the coal mines of the United Kingdom is estimated at 4½ million tons, of the value of £5,000,000. The chief supply in the year 1913 was obtained from Russia, France, Sweden, Portugal and Norway. On the outbreak of the European war it became evident that the supplies of pit wood would be largely curtailed, and the Board of Trade took steps to ascertain how far other existing sources of supply would meet requirements. Among the new sources from which pit wood could be obtained was Newfoundland, and a Commission of Inquiry was dispatched there and a report was presented in December, 1914 (Cd. 7728). It was stated that very large areas of suitable timber exist in the island, a considerable proportion being close to the seashore or to many bays and rivers, and therefore easily transported to the various points where it could be loaded on to steamers. The suitable timber consists of fir and spruce, the former being a more quickly-grown timber than the latter. Within three miles of the shore over the whole island the timber rights are reserved by the Government. Ordinarily anyone may cut timber on this three-mile limit for firewood, house-building, boat-making and other purposes, but not for export, except in the form of pulp. By a special Act since the outbreak of the war the Government have sanctioned the export of pit wood, and this concession is still in force, and probably may be continued until the end of the war. The conclusion arrived at by the Commission of Inquiry was that Newfoundland could apparently be equal to an annual output of 300,000 cords of pit wood, and that it could meet nearly half the shortage from the Baltic occasioned by the war. After some trial shipments had been made, and the pit wood was found to meet fully the requirements of the collieries, a considerable trade has been established between Newfoundland and the United Kingdom. Last year thirty-three cargoes were shipped, and others are likely to follow during the coming summer. If pit wood is supplied at an average price of about $5 per cord and, say, one-half of the annual quantity mentioned above is shipped, this would mean that an additional £100,000 would be circulated in wages amongst the working people of Newfoundland.

Re-afforestation.

This is a subject that intimately concerns the success of the wood-pulp industry in Newfoundland. It has already received some attention. Mr. Reuben F. Horwood stated that the rapid growth of the trees is an item of great value in the reproduction of the Newfoundland forests. Along some of the watercourses and on the low-lands near the river outlets the forests would produce a new growth in fifteen years. On an average over the island he thought that the new growth might take thirty to fifty years. Where the larger trees were cut out the smaller trees that were left grew more rapidly, and under such conditions a rotation of twenty to thirty years might be possible. Mr. Vincent Jones was of opinion that, "with judicious and scientific safeguards," the forests might be rendered capable of indefinite reproduction. The uniformly moist climate of Newfoundland is very favourable to the rapid growth of trees.

The Royal Commission recommended that, in order that the forests of Newfoundland should be a permanent asset, it was necessary to lay down scientific regulations as to the conditions on which cutting should be permitted. It added, "whilst the larger operators may no doubt lay down certain rules to suit their own convenience, experience elsewhere shows that Government control on such a question was essential. We venture to suggest that the Newfoundland Government should devote its early attention to this question."

Forest Fires.

As in Canada and elsewhere, it was becoming a matter of serious concern to guard against forest fires. The evidence given before the Royal Commission in Newfoundland indicated the gravity of the situation. Mr. Horwood stated, "during the past twenty years the average loss to the country from forest fires would be from £1,000,000 to £2,000,000 annually." In his opinion, "before any reforms in cutting or re-afforestation methods are considered, this criminal waste of public wealth should be dealt with, for it constitutes the most serious problem in conservation that Newfoundland had to consider." The forest fires in Newfoundland are said to be caused in large proportion by railway trains; also by sportsmen, and to some extent by careless woodmen. The Deputy Minister of Agriculture reported that, "unfortunately in the past large sections of the best timbered country have been burnt over by forest fires, but of late years the organisation of a forest fire patrol by the Government, with the assistance of the operating lumber companies, has considerably lessened the danger of loss from this cause."

Mr. Vincent S. Jones stated that the Anglo-Newfoundland Development Company had organised its own system of fire wardens for the protection of their property from fires caused by the railway. During the past four years the system "had been successful, and between five and six hundred fires have been put out annually, which might have developed with bad results."

The Royal Commission drew special attention to the danger from forest fires as follows: "It was stated in evidence before us, that during the last twenty years the average loss caused by fire has been very heavy, and much of the damage is said to have originated from the sparks from railway engines. Complaint was made that, though the law requires precautions to be taken, and the most approved spark-arrestors to be used, it is not properly enforced. The fitting of a suitable spark-arrestor is easy and inexpensive, so that there is little excuse for negligence in this matter."

"Recently the Government has made an appropriation of £1,042 annually for the appointment of a chief ranger and fire wardens, and a further appropriation of £833 for the establishment of a fire patrol. This latter sum is supplemented by small payments by licensees (which, however, are entirely optional), amounting in 1913 to less than £1,000. It appears to us that these sums are unduly small considering the magnitude of the interests involved."

Steamship Communication and Cables.

The Royal Commission reported that the coastal services and direct services with Canada and the United States leave little to be desired. There is a daily service across the Cabot Strait with Nova Scotia, and a regular weekly service with Halifax and New York. The means of direct communication with the Mother Country is not so satisfactory. Although there is a subsidised steamer service costing the Colonial and Imperial Governments £4,000 per annum, the Royal Commission reports that the most modern and fastest boat running between the United Kingdom and Newfoundland is the property of an unsubsidised company. It adds: "We entirely agree with the views expressed by the Prime Minister of Newfoundland at the Imperial Conference in 1911 as to the need for a faster and better service, and we cannot recommend the continuance of the present state of affairs."

Newfoundland is exceptionally favoured as regard cable services, and therefore in a position to assist in promoting Imperial trade. Nine Atlantic cables are landed near St. John's, and are laid thence to New York and Canada. One cable, which is entirely under the control of the Newfoundland Government, connects St. John's and Nova Scotia and other parts of Canada.

In addition to the cable services, a through wireless service from the United Kingdom to Newfoundland is now in operation.

Appendix.

The following information, communicated as the result of comparatively recent observation in Newfoundland, by Mr. Richard W. Wilson, M.I.Mech.E., will be read with interest:—

"I travelled inland from the coast on the east, west, and south side of the island, and although the higher elevations as well as the coast line were barren, the inland valleys were well wooded.

"At the sides of the rivers and lakes I saw large tracts of spruce and fir, and also some pine and birch. Most of this timber was straight and sound, and admirably adapted for the manufacture of pulp; but there was a fair proportion of trees also large enough for the manufacture of good lumber. The tallest trees reached a height of quite 70 ft., many of them being over 20 in. in diameter, and they were so situated as to be easily transported to the tidal waters. Excellent sites for the erection of mills and for

the loading of ocean-going ships existed, too, in very many places. Waterfalls for providing power were plentiful also.

"I was told by the inhabitants that re-afforestation of these timber lands where the wood has been cut down takes about forty years; but, even if one adds ten years to that, a very large perpetual supply of wood is obtainable both for lumber and pulp, sufficient to keep at least half-a-dozen pulp-mills going, and lumber-mills besides, working full time.

"Labour is plentiful, for when this is most required in the logging camps the fishing is over; and the Newfoundlander is as handy with his axe as he is with his oar and his tiller. Newfoundland is certain to become a valuable source of pulp and lumber to this country, for there the trees are, and none of the forests are at a great distance from the sea.

"Moreover, Newfoundland is not so much bound up with ice as most other countries are which produce this class of timber. Heavy ice packs, certainly, are driven in on the east and west coasts in the late spring; but the south coast is entirely free from drift ice. The temperature of Newfoundland never reaches the low degrees it does in Canada, and the thaw sets in earlier. Jutting out into the Atlantic to a much greater distance than most people realise, Newfoundland is much nearer the Mother Country for shipment of its produce than most of the countries from which are derived the increasing tonnage of lumber and pulp."

DISCUSSION.

Lord Northcliffe said the fact that he was coming to the meeting became known to someone, who remarked that he (the speaker) might be more usefully employed in doing something for the war. As a matter of fact, the development of the forest lands of Newfoundland was doing something for the war. Quite lately one of England's neutral friends had placed an embargo on the export of material which we are obtaining in great abundance from our oldest colony. It was due to Mr. Mayson Beeton and others, who were the real pioneers of the wood pulp industry in Newfoundland, that the newspapers with which he was associated were not entirely dependent for their supplies upon neutral countries. The prime reason for fixing upon Newfoundland was the certainty they felt with regard to the coming of the war. The forests of Newfoundland were so tightly packed that much of the work of cutting down the trees consisted in merely clearing the forest and letting in light, and as a matter of fact the forests throve much better after the clearing process had been adopted than they did in their primeval state. The interior of Newfoundland was extremely little known. Although on the map it appeared to be divided into locations all over the island, very few people indeed had ever crossed the island in more than one direction; but those who had crossed it had been able to bring back news of very valuable plantations of timber that could be made into paper. Newfoundland possessed many advantages for the manufacture of paper, and many other sources of wealth, and he had no doubt that if the island had been in the hands of the Germans it would have been long ago exploited. It was a colony more valuable than any single German colony, but, perhaps owing to the fact that Great Britain possessed such vast dominions, the island had not been exploited any more than Australia had been exploited. Sir Daniel Morris had indicated the kinds of wealth that had been produced by the very haphazard methods by which the British Empire had been developed. One of the advantages of the great war—and even the war had some advantages, although they were hard to see at the moment—was the fact that it caused this country to concentrate attention on the things within its grasp. Two years ago it would have seemed impossible to bring pit-props from Newfoundland for the coal mines in Great Britain; but that had been done, and he had seen trenches in Flanders also supported by pit-props from Newfoundland. So that the little colony, neglected for hundreds of years, had come into prominence by the declaration of war in August, 1914. The islanders were tremendously patriotic. They were almost entirely of English, Scotch, and Irish ancestry, the great proportion of them being descendants of Devonshire men. They had sent to Gallipoli and Flanders a very considerable portion of their 243,000 population. Only that day he had had the pleasure of reading a message sent to the Governor of Newfoundland from Headquarters, thanking the island for the fine men it had sent to the war. When it was remembered how very remote the island was from the war and the rest of the world, it would be realised that that was a great achievement. The reading of the island was naturally very largely composed of American publications, New York being within two and a half days by post. He considered the patriotism of the islanders who had thrown up their vocations and come to the help of the Mother Country one of the most touching things in the whole history of the war. Their bravery in Gallipoli, which possessed a climate entirely unsuited to them, was splendid. No one but the War Office could have conceived the idea of sending men from a land of ice to one of the hottest parts of the world, but the conduct of the men was such as to call forth the commendation of General Cayley on the spot. Not satisfied with the contingent it had already sent, Newfoundland was busily engaged in raising another contingent. When the words of Sir Daniel Morris and Sir William MacGregor, one of the best Governors Newfoundland ever had, were read by the people of that colony, they would see how

grateful this country is to them for their help in material and in men.

Mr. A. Ralph Reed said it was a pleasant thing to find in the centre of London so much interest shown in the forests of Newfoundland, because in the ordinary way Newfoundland was apt to be rather overlooked, lying as it did under the shadow of its greater neighbour, Canada. There was no doubt that the Newfoundlander was extraordinarily deficient in his appreciation of timber; he would think nothing of cutting down a large tree for the sake of a small part, when he could get what he required by going a little further on. It had been said that a Newfoundlander who was fly-fishing, and whose fly caught in the branches of a tree, would cut the tree down to get his fly! As time went on, that defect in his character would, no doubt, be remedied. It was very difficult to get the Newfoundlander to settle down to any kind of industrial labour. He had been told by the superintendent of a large mill that, with the exception of a few of the foremen and leading hands, practically every man in the mill had left and returned at least three times; but as almost the whole countryside knew how to work in a pulp-mill, there was no difficulty in obtaining fresh hands. The Newfoundlander was also the most self-confident person in the British Empire, and never appeared to be taken by surprise. When the magnificent new paper machines were started at Grand Falls, the Newfoundlander made a special point of regarding them as if he had a similar machine in his own parlour.

Mr. S. Charles Phillips said he had travelled a good deal in Newfoundland, and had taken great interest in all matters that appertained to the manufacture of wood pulp and its further manufacture into paper. The paper question was one of extreme seriousness to Great Britain, which was so much dependent upon foreign countries, more particularly Scandinavia, for the raw and manufactured product. It was to be hoped, for the sake of the country, that the mill at Grand Falls would be the forerunner of many other mills, not only in Newfoundland but in Canada, to which this country could look to provide wood pulp and, if necessary, paper. Sweden had placed an embargo on chemical wood pulp, which must of necessity be incorporated in all grades of paper, in order to give it strength and backing, and it was owing to Sweden's action that Great Britain was confronted with what might be a paper famine. A great deal of the wood pulp was now being sent by Sweden to Germany, where it was turned into a base for high explosives. He was pleased to know that there were schemes in course of development which it was hoped in time would greatly assist this country in being independent of the whims of other countries, friendly or otherwise, and Sweden would only have herself to thank for the diversion of trade from her shores to Canada and to Newfoundland.

Mr. R. D. Wilson, M.I.Mech.E., in proposing a vote of thanks to the author for his interesting paper, said it would be useful not only to Newfoundland but to many who had sought information about the forests of the island and had been bewildered by the conflicting statements given by the Newfoundlander concerning his forests. He hoped that when the people of Newfoundland awoke to the importance of the forests they would be wise enough, in taking up the question of re-afforestation, not to start by re-planting saplings, as was done in many countries, notably Germany. The forests of Newfoundland were chiefly spruce. As the pulp question was so important, it was also important that the spruce should be re-afforested; and as people believed that when the trees in a forest were cut down other trees very often grew in their place, he wanted to mention that it was more a matter of climate than soil by which Newfoundland re-afforested itself in spruce. Spruce required a large amount of water, and the tree had no doubt selected Newfoundland because of the immense supply of water in the subsoil there. Temperature did not interfere with the growth of the trees, because the highlands of Siberia were the coldest portions of the earth, and yet the trees grew there. Re-afforestation took place naturally in Newfoundland by the birch first of all occupying the soil, and being elbowed out a few years later by fir and spruce; then came a struggle between the fir and the spruce, and eventually the spruce predominated, especially on the south coast in the neighbourhood of the Gulf Stream. When the Government decided on re-afforestation he hoped they would call to their aid such men as Sir Daniel Morris, who would warn them not to begin by planting saplings, but to trust to the forces of Nature. The French had followed that method in their oak forests.

Mr. Byron Brenan, C.M.G., seconded the motion, which was carried.

Sir Daniel Morris, in responding to the vote of thanks, desired to express his great indebtedness to the Director of the Royal Gardens at Kew for a set of fresh specimens of the principal Newfoundland trees used for paper and pulp purposes, and pit wood; to the Director of the Imperial Institute for the loan of logs of spruce and balsam fir, and for three samples of pit wood; to the Anglo-Newfoundland Development Company for a sample reel of news paper; and to the A. E. Reed Company for a sample of mechanical wood pulp which forms the chief constituent of ordinary news paper, and for a large picture of their pulp mills in Newfoundland; also to Miss Willmott for a branch of the balsam fir from her garden at Great Warley, Essex.

Sir W. MacGregor has since forwarded the following note upon Labrador timber:—I found that on the Hamilton River the trees were chiefly black spruce, but with a mixture of white spruce and "var," with some "balsam," fir, poplar, and aspen. The trees were generally

40 to 50 ft. high, but many white spruce went up to 70 or 80 ft. It seems that experts have stated that the black spruce of Newfoundland gives the best paper-pulp in the world. In Newfoundland forest fires have done immense damage to the forests. Fires were more rare in Labrador, and the result was that very little forest was occupied by the rather useless birch. In the north of Labrador, beginning at Hudson's Straits, there is no timber. I made as complete a collection of the botany about Cape Chidley as was possible during the week I spent there, and, so far as I remember, the tallest tree I found was a willow about two inches high. Not very long ago I saw in a certain national gallery a picture of Cape Chidley which not unnaturally interested me very much, more especially as it represented some picturesque rather storm-beaten spruce trees growing in the crevices of the rocks, with large numbers of very ordinary-looking penguins standing at attention on the cliffs. The artist had probably read something sometime about the garefowl of Newfoundland seas, a bird to which apparently the name "penguin" was first applied. About the entrance of Hudson's Straits very little drift timber is procured, but near to some of the Moravian stations further south there are patches of forest whence a certain amount of firewood can be procured. In my time in Newfoundland there were some negotiations on foot for concessions of those patches of forest to Europeans. It would be absolutely wrong for any governor or government to sign away any such concessions in the Esquimaux country, as this would not only deprive them of the bit of firewood that it is possible for them to secure, but would also most injuriously affect the few fur animals that remain. It has to be remembered that trees grow very slowly in northern Labrador. Firewood could, when I was there in 1908, be obtained in the Bay of Nepartok, some twenty miles from Hebron, say 150 miles from Killineek, on the west side of the Chidley peninsula. But the Esquimaux complained bitterly that when they prepared firewood there and stacked it for drying, it was stolen in a wholesale manner by the white fishermen. Dr. Grenfell was also a sufferer from the same cause. On the hills near Chateau Bay I saw numbers of very extraordinary larches, several of them not more than a foot or two in height, spread out like a great gridiron with a diameter of three or four yards. From the acting manager and the foreman of the Grand River Pulp and Lumber Company on Mud Lake, near the mouth of the Hamilton River, it was learned that the timber sawn there was almost entirely black and white spruce, and "var." The last is the fastest grower, and yields the worst timber; the white spruce is the largest tree, and gives the best timber. The oldest tree they had seen had 171 rings of growth, and a diameter of 3 ft. It had been noticed that a tree of 6 in. in diameter at the base would have about 40 rings. I carefully examined two logs of white spruce that had been procured for the mounting of a saw-mill on the Kennimon River, and found that one with a base circumference of 6 ft. 5½ in. had 212 or 214 rings, as counted by two different men; the other had a base circumference of 7 ft. 1 in., and 235 or 240 rings, as counted by the same two men. A very fine Coddington lens was used in this count, and the line on which the counts were made was shaved clean by a sharp knife. Naturally the rings near the circumference were exceedingly thin. The trees were perfectly sound at the heart. These were the oldest spruce trees I had known. I came to the conclusion that under favourable circumstances spruce trees grow in height in Newfoundland about a foot a year. The smallest logs being sawn at Mud Lake, at the time of my visit, had a diameter of about 15 in., and counted about 60 rings. It may be worth while to advert in a few words to a kind of forest that may become of considerable importance within the jurisdiction of that colony. I refer to the submarine forest. In no other place have I seen such fine seaweed, laminaria, as on the Labrador coast. It is hardly necessary to say that agriculture, already in a condition of active evolution, will be still more so when this awful war is over. The cultivation of the fields must steadily become more and more intensive. That means better preparation of the soil, and a greater use of artificial manures. Everyone concerned in agriculture knows that this means the liberal use of nitrates, of phosphates, of potash, and of lime. It is in regard to the supply of potash that I wish to speak. It may be mentioned in passing that Newfoundland, in the Hamilton River alone, could have water power sufficient to manufacture an unlimited quantity of nitrolin from the nitrogen of the air, as is now being done in Norway on a large scale. Potash is simply indispensable in vegetable growth; indeed, no cell can grow without it. It is absolutely necessary in the production of carbohydrates. It is required in large quantities in growing cabbages, turnips, potatoes, barley, etc. You may know that Germany has immense deposits of potash in the vast deposits of salts at Strassfurt in Saxony, and in other places, and that in this supply she has practically a monopoly of the supply in the so-called kainite, which contains the chloride and the sulphate of potash. The potash question has been a matter of bargaining between Germany and the United States, and the latter have offered large rewards for the discovery of potash deposits at home, so as to be independent of Germany. The natural supply of potash to the soil is chiefly from the decomposition of granite, which may contain as much as 5 per cent. of potash, but as an acre of potatoes, for example, will require, say, from 1 to 2 cwt. of potash, the soil soon becomes exhausted. In spite, however, of the tremendous supply required by America, it was reported in our *Board of Trade Journal* of January 14th, 1915, that the United States can obtain more potash than they require from the seaweed

of 400 square miles of their Pacific coast. This means the establishment there of the old industry of the western islands of Scotland, the preparation of "kelp." It takes about twenty tons of the laminaria to give one ton of kelp ash. And the ashes will contain about 10 per cent. of the sulphate of potash, and some 13 per cent. of the chloride, the same salts as exist in the German deposits. The laminarias contain other ingredients that are of some value. Now, as the seaweed only requires to be collected and dried, and as it will burn without other fuel, the preparation of kelp ash, or of potash salts, could be made an important industry for the Esquimaux and the other settlers on the Labrador coast; and at the same time supply the United Kingdom with all the potash required here. The leader of the National-Liberals in the German Reichstag lately stated in parliament that to meet the interest on the cost of this war Germany will require additional taxation to the extent of £200,000,000 a year. The chances are that under such circumstances a heavy export duty will be put on kainite if Germany continues to have a monopoly of the supply. It would be well worth the trouble to examine the Labrador coast to see whether, with the labour to be had there, and the fine laminarias obtainable, the kelp industry could not be worked so as to meet our wants in potash for agricultural purposes, and render us, too, independent of the German supply.

MEETINGS OF THE SOCIETY.

Ordinary Meeting.

Wednesday afternoon, at 4.30 p.m.:—

May 3.—Sir Henry Hardinge Cunynghame, K.C.B., Member of the Royal Commission on Food Supplies, 1905, "Supply of Food in Time of War."

Colonial Section.

Tuesday afternoon, at 4.30 p.m.:—

May 2. — The Right Hon. Sir William MacGregor, G.C.M.G, C.B., LL.D., D.Sc., "Some Native Potentates and Colleagues." The Right Hon. Viscount Bryce, O.M., D.C.L., LL.D., F.R.S., will preside.

Cantor Lectures.

Monday afternoons, at 4.30 p.m.:—

J. Erskine-Murray, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures (May 1, 8, 15, 22).

Syllabus.

Lecture I.—May 1.—*Periodic Motions.* Definitions and modes of production—Stable and unstable equilibrium — Inertia, gravity, and elasticity — Pendulums and spring oscillators of various kinds —Torsional vibrations, balance wheel—Corrugation of rails—Musical instruments—Complex vibrations and the quality of a tone—Vibrations on large scale, seismic tremors, vibrations of ships and buildings, lightning.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 1...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Dr. J. Erskine-Murray, "Vibrations, Waves, and Resonance." (Lecture I.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. H. J. White, "The Connection between the Vulgate Version of the Bible, and the Theology of the Western Church."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. J. S. G. Thomas, "The Evaporation of Naphthalene in Dry and in Moist Coal Gas." 2. Professor F. Clowes, "An Historical Summary of our Knowledge of Sulphur in Coal Gas."

Farmers' Club, at the Surveyors' Institution, 12, Great George-street, S.W., 4 p.m. Mr. A. Amos, "Clover Sickness."

Engineers, Society of, Caxton Hall, Westminster, S.W., 5 p.m. Conference on "Engineering and Scientific Research," to be opened by Dr. J. A. Fleming.

Tuesday, May 2...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Sir W. MacGregor, "Some Native Potentates and Colleagues."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. L. Binyon, "Indian and Persian Painting."

Alpine Club, 23 Savile-row, W., 8.30 p.m. Captain L. S. Amery, "Mountain Walks in the Balkans."

Wednesday, May 3...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. Sir H. H. Cunynghame, "Supply of Food in Time of War."

Civil Engineers of Ireland, Institution of, 35, Dawson-street, Dublin, 8 p.m.

Sanitary Institute, 90, Buckingham Palace-road, S.W., 5.30 p.m. Dr. A. Waller, "The Economics of Food Supply in War Time."

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. W. H. Willcox and J. Webster, "Salvarsan and Neo-Salvarsan, Excretion and Secretion of." 2. Mr. H. G. Greenish, "Microscopical Methods."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m.

Thursday, May 4...Linnean Society, Burlington House, W., 5 p.m. 1. Mr. E. A. Bunyard, "The Origin of the Garden Red Currant." 2. Dr. J. C. Willis, "The Dispersal of Organisms, as illustrated by the Floras of Ceylon and New Zealand." 3. Mr. R. J. Tillyard, "A Study of the Rectal Breathing Apparatus in the Larvæ of the Anisopterid Dragonflies." 4. Mr. W. E. Collinge, "Description of a new species of *Idotea* (Isopoda) from the Sea of Marmora."

Chemical Society, Burlington House, W., 8.30 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Sir E. Ray Lankester, "Flints and Flint Implements." (Lecture I.)

Iron and Steel Institute, at the Institution of Civil Engineers, Great George-street, S.W., 10.30 a.m. (Annual Meeting.)

Friday, May 5...Royal Institution, Albemarle-street, W., 5.30 p.m. Sir J. M. Davidson, "Electrical Methods in Surgical Advance."

Iron and Steel Institute, at the Institution of Civil Engineers, Great George-street, S.W., 10 a.m. (Annual Meeting continued.)

Geologists' Association, University College, W.C., 7.30 p.m.

Textile Institute, Manchester, 2.30 p.m. (Annual Meeting.)

Saturday, May 6...Royal Institution, Albemarle-street, W., 3 p.m. Professor W. H. Bragg, "X-rays and Crystals." (Lecture I.)

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FRIDAY, MAY 5, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MAY 8th, 4.30 p.m. (Cantor Lecture.) J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." (Lecture II.)

WEDNESDAY, MAY 10th, 4.30 p.m. (Ordinary Meeting.) SIR FRANCIS TAYLOR PIGGOTT, M.A., LL.M., Chief Justice of Hong Kong, 1905-1912, "Neutral Merchants and the Rights of War." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

COLONIAL SECTION.

Tuesday afternoon, May 2nd, 4.30 p.m.; THE RIGHT HON. VISCOUNT BRYCE, O.M., D.C.L., LL.D., F.R.S., in the chair. A paper on "Some Native Potentates and Colleagues" was read by THE RIGHT HON. SIR WILLIAM MACGREGOR, G.C.M.G., C.B., LL.D., D.Sc.

The paper and discussion will be published in subsequent numbers of the *Journal.*

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

EIGHTEENTH ORDINARY MEETING.

Wednesday, May 3rd, 1916; CAPTAIN CHARLES BATHURST, M.P., Chairman of the Central Chamber of Agriculture, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Alcoff, William, c/o J. K. Robinson, Iquique, Chile, South America.

Apcar, John Gregory, 44, Chowringhee-road, Calcutta, India.

Barnes, Professor James Hector, B.Sc., F.I.C., Punjab Agricultural College, Lyallpur, India.

Black, Professor A. Bruce, State Normal School, Bloomsburg, Pennsylvania, U.S.A.

Goculdas, Narottam Morarjee, Shanti Bhavan, Pedder-road, Bombay, India.

Horne, William Edgar, M.P., 5, Tilney-street, Park-lane, W.

Isachsen, Halfdan B., Stavanger, Norway.

Janji, Suryabhan, Camp Keliweli, Akola District, Berar, India.

Mukhopadhyaya, Kumar Sree Panchanan, Uttarpara Raj, Uttapara, Bengal, India.

Newlands, Alexander, M.Inst.C.E., Highland Railway, Inverness, Scotland.

Northcliffe, Lord, 22, St. James's-place, S.W.

Oakden, William Edward, F.C.S., M.S.C.I., 11, Lonsdale-road, Barnes, S.W.

Saklatvala, Nowrojee B., Messrs. Tata, Sons & Co., Navsari Buildings, Fort, Bombay, India.

The following candidates were balloted for and duly elected Fellows of the Society:—

Adenwala, Moteeram Heerabhoy, Heera Bag, Shahibag Post, Ahmedabad, India.

Kale, Professor Vaman Govind, M.A., Fergusson College, Poona, India.

Khan, M. A. Lateef, Furhut Munzil, Saifabad, Hyderabad, Deccan, India.

The paper read was—

SUPPLY OF FOOD IN TIME OF WAR.

By SIR HENRY HARDINGE CUNYNGHAME, K.C.B.

The present war with Germany has brought forcibly before the country the question of securing adequate supplies of food in time of war, and for that purpose I desire to call

attention to the findings of the Royal Commission appointed to consider that subject in the year 1903.

I do this not merely with a view of resuscitating forgotten controversies, but of calling attention to a plan proposed by me which obtained the support of the dissentient minority, as well as the somewhat guarded approval of the majority of the Commissioners.

The Commission was presided over by Lord Balfour of Burleigh. His present Majesty, then Prince of Wales, was a member of it, and it comprised, among others, Lord Burghclere, Lord Chaplin, the late Duke of Sutherland, Sir Henry Seton-Karr, Mr. Edmund Robertson, the Comptroller of the Board of Trade, two admirals, the Oxford Professor of International Law, Lord Emmott, the president of the Liverpool Corn Trade Association, and Mr. John Wilson, M.P.

I had also the honour of being a member, in my capacity as one of the officials of the Home Department.

It is interesting, after the lapse of thirteen years, to look back at the problem as it was then presented and to examine the findings of the Commission in the light of subsequent events.

The importance on the outbreak of war of a sufficient supply of food is too obvious to need proof. The remarks which follow apply to almost all kinds of food, about five-sixths of which come to Great Britain from abroad. But corn is chiefly under consideration, because it forms the principal article of diet among civilised peoples, and is being consumed in increasing quantities by savage nations. In Great Britain nearly one-fourth of the money expended on food is spent upon flour and bread.

The wheat lands of the world though not nearly exhausted are not illimitable, and it does not seem probable that the price of wheat will ever again fall so low as it was in the first years of the present century.

Roughly speaking, the annual consumption of corn is 350 lb. for each head of population, or rather more than 30,000,000 quarters (of 480 lb. each). Of this amount in 1903 about 6,000,000 was produced in Great Britain, 10,000,000 came from the British colonies, 6,000,000 from Europe, 4,000,000 from the United States, and 5,000,000 from South America and elsewhere. The principal routes by which it came were the Atlantic, which carries 60 per cent., and the Mediterranean, by which there comes about 13 per cent. In winter there were usually about 4,000,000 quarters of wheat at one time on the ocean coming to us, and about half that amount in the summer. During the spring wheat begins to come from the Pacific coast of America, in April it begins to arrive from Australia, in May from India, in August the American winter wheat begins to arrive, in October we get wheat from Rumania, and in November the arrival of the Canadian wheat commences.

Our stores of wheat in this country vary from seventeen weeks' consumption in November down to about five or six weeks' consumption in August.

These figures include wheat in stores, wheat in the hands of millers and bakers, and wheat in the hands of farmers. In fact they represent our total available supply. I have preferred to give the figures proved before the Royal Commission. They are somewhat different from the figures of to-day. For instance, we now produce about 7,000,000 qrs. of wheat instead of 6,000,000, but the figures are not so different now from what they were at the date of the Royal Commission as to make any material difference to the argument or the conclusions.

It follows, then, that if at a critical period an enemy could intercept our imports of wheat, even for a short time, our position would certainly become very serious.

Now it must be remembered that the production of wheat differs from that of manufactured articles and of much other raw produce, chiefly in this, that it is seasonal. It is not eaten as produced. On the contrary, though some of it is eaten at once, the remainder is eaten at varying periods up to a year at least after it is reaped, and in some cases longer still. Hence it must be stored. In order to secure its preservation it must be kept dry, and well aërated. It must occasionally be cooled, because like all stored seed it tends to heat when kept in large masses.

In the case of American wheat this storage is done in America. Minneapolis and Chicago alone are computed to have storage capacity for over 11,000,000 qrs. And in America there is probably storage for 100,000,000 qrs., or three times the whole annual consumption of Great Britain. America need not fear starvation by any war that is not waged upon her own territory. The cost of such storage for a year on each quarter of corn is estimated at 1*s.* 6*d.* for interest on capital, 1*s.* 6*d.* for rent of store, and 9*d.* for inspection, carting, aërating, etc., making a total of from 3*s.* 9*d.* to 4*s.* This cost

of storage is inevitable; it must be incurred and forms part of the cost of production of wheat.

We may naturally ask, What are the securities which ensure us against a deprivation of our wheat supply? The first, of course, is our Navy. But it must be borne in mind that our Navy can only be effectual as a weapon of offence. We cannot scatter it so as to protect trade-routes. All we can do to protect those routes is so to threaten the enemy's navy that it dare not detach any considerable forces to attack our trade.

The second security we have is, that at the time we are at war with some foreign Power a wheat-producing friendly neutral can still supply us. This supply could only be prevented in two ways. First by the extension of an effective blockade to all our ports. In this case, if wheat were declared by our enemy to be contraband of war, on the ground that it might feed our troops, the enemy might take the wheat and the neutral vessels carrying it. Secondly, our enemy might decide to be bound by no rules of war, and to sink at sight and without warning all ships, both ours and those of neutrals, which were found carrying wheat to our ports. And what is to prevent him? Simply our own force or the force of the neutral whose ship was taken. For although such action by our enemy would be illegal from the point of view of international law, yet there is nothing binding other neutral nations to enforce international law. It is at present only a code which he may keep who chooses and he may break who can. The enforcing of it on third parties is no part of the duty even of those by whom it was agreed and formulated.

Again, although according to the laws of war a cruiser has only a right to destroy such ships and cargoes as she cannot take into port, there is nothing to prevent her from sinking them at sight if she is ordered to do so by a government that has decided to obey no moral or international code.

The majority of the Royal Commission formed the opinion that, though there might be some uncertainty as to whether the rules of international law would be observed by an enemy with whom we were at war, yet that public opinion would have a restraining influence on its breach, and that the interests of neutral nations in supplying us with food would count for something. Moreover, the Admiralty had given its opinion that, in case of war with any two great maritime Powers, our supplies from oversea would not be very materially diminished.

On this assumption, and on the assumption that the rules of international law remained unchanged, the majority of the Commission came to the conclusion (par. 250, p. 59) that: "Not only is there no risk of a total cession of our supplies, but no reasonable probability of serious interference with them, and that even during a maritime war there will be no material diminution in their volume, unless we sustained such a naval disaster as to lose command of the sea" (par. 116, p. 27).

In view, however, of the rise in prices which a war would bring about, the Commission, in a very hesitating way, advised that a scheme for encouraging wheat storage, by "offering storage room rent free, would be open to the fewest objections" (par. 261, p. 61). (*See* Report, Parliamentary Blue Book, 3 vols. [Cd. 2643, 2644, 2645, 1905].)

This report, however, was not unanimous. It met with opposition on the part of the late Duke of Sutherland, Lord Chaplin, the late Sir Henry Seton-Kerr, Professor Holland, and the author.

We did not dispute the view that, until the British Navy had been put out of action it would be impossible to cut off our corn supplies; but we considered that, even assuming that we were to risk all on our Fleet, yet that in view of the great rise in price which even a partial defeat might cause, some steps should be taken to increase the supplies normally present in the country.

A number of schemes had been proposed. One was Government aid to farmers at home, to induce them to store their crops for a time before selling them. The disadvantage of this plan is that farmers have not got proper arrangements for storing wheat, which is subject to attacks by vermin, to heating and deterioration; and besides, British wheat does not keep so well as Canadian or Australian.

Another proposed plan was for the Government to buy and store wheat and to sell it from time to time according to some pre-arranged scheme or some sliding scale. This plan, however, was condemned by all the members of the Commission, both on account of the disturbance to trade and the difficulty of fixing the prices (Report, par. 259, p. 60, and Dissentient Report, par. 78, p. 80).

The plan of subsidising merchants to induce them to keep stocks of wheat was likewise on all sides disapproved.

The next proposal, known as the schemes of Mr. Govan and Mr. Marshall Stevens, for

providing free storage, met with a hesitating approval from the main bulk of the Commissioners, and was recommended by the dissentient minority.

The plan was to subsidise companies who would erect stores, by paying them 6*d.* a year for twenty years for every quarter of corn for which they provided accommodation. In consideration of this the companies were to offer storage free of rent up to the capacity of their stores, to all who demanded it. This would apparently leave to be paid by the persons storing the wheat the cost of inspecting, carting, aërating and loss of interest, say, altogether about 2*s.* 6*d.* per quarter per annum (Report, p. 48). Observations upon this plan were offered by the principal dealers in wheat in the United Kingdom (Report, p. 190 *et seq.*).

The gist of these observations was that the importers of wheat would not take advantage of the plan, and the reasons given are very interesting and instructive. For instance, that "when grain is once stored there is a more limited market for it." No merchants "would care to have their goods locked up for sale in any particular area." "Favourable market conditions could not subsist concurrently with full granaries. Such stocks would annihilate all prospects of profits on the corn merchant's ordinary trading." "No doubt it would be a good thing for the millers of the neighbourhood, but it would largely obviate the necessity of the millers keeping stocks in their mills, and the probable effect would be that there would be actually less grain in the particular district than if the warehouse were not in existence." One writer suggested that we ought to have a navy "strong enough to convey our supplies across sea in spite of all opposition." Another "that the farmers ought to be subsidised to enable them to grow wheat." One very frankly said, "If I sell wheat in America for May delivery in Chicago or New York, it is obviously useless to me if stored in Great Britain. I not only miss my local speculation and milling demand, but I am absolutely tied to one market for export, instead of having the choice of the whole of Europe, and a mere concession of 2*d.* per bushel (*i.e.*, 16*d.* a quarter) in rent would in no way compensate me for loss of market." Another wrote, "Very little grain now comes to this country on account of foreign owners who are wise enough to know that if held in their own country they have all the markets of the world open to them during the whole time they are holding their grain, and can sell it any day they like, instead of being obliged to wait until the buyers of that market choose to purchase, which would be the case if they shipped unsold to this country."

And verbal evidence was given to the effect that corners and combines are more easy to "engineer" if the stocks are kept in the country of production than if they are stored in the country of consumption (*Q.* 1106). These replies make it clear that the reason why wheat is stored in the country of production is because it gives the wheat speculators and dealers an advantage in that they can to a large extent regulate prices in the country of consumption by retaining the power up to the last moment of sending it to one market rather than to another. Thus, for instance, if the wheat is stored in America, and a sudden demand for it arises in some part of the world, either from war or other cause, the enhanced price caused by a sudden increased demand is felt in all those countries that have not got a considerable quantity of stored wheat, and they will be subject to every fluctuation produced by any cause. On the contrary, a country that has a large wheat supply stored up is much less subject to variation of price. A large supply of wheat acts like the fly-wheel of an engine. It steadies prices and causes fluctuations to become less abrupt.

I have quoted these replies and evidence, not because so obvious a truth needs proof, but because it is not often that those engaged in a trade so freely admit the means adopted by them to "engineer" their profits. They are, of course, no worse than other men, nor do they probably make more money than other people; but the reasons they give for objecting to storage in Great Britain are the very reasons that ought to make the public insist upon it. For it is precisely at crises that all this price-engineering procedure comes into play, and it is certain that the raising of prices would be prevented, not only in time of peace but still more in time of anticipated war, if larger stocks were held in Great Britain.

I now pass to the consideration of the plan which I suggested. After the lapse of thirteen years I can only say that the more I reflect upon the matter the less objection I can see to it.

I had better, I think, reproduce it in the form in which it was placed before the Royal Commission (Vol. III. Appendices to the Report, XLIV. p. 327), together with the criticisms to which it was subjected.

APPENDIX No. XLIV.

Scheme Proposed by Mr. H. H. S. Cunynghame, C.B., a Member of the Commission, for Obtaining a Stored Supply of Foreign Wheat in the United Kingdom.

It must have struck everyone how inconvenient and dangerous it is to us that in the necessary interval between the harvest and consumption of wheat the grain should be kept in America and other foreign countries rather than in the United Kingdom.

We have evidence that it costs no more to store and handle wheat in the United Kingdom than in America (*Q.* 811, 1288, 1325, 1378, 1490, 1721, 1926, 2061). The reason why corn is kept at present in America, rather than in the United Kingdom, seems principally to be the increased control it gives to the corn speculator, who, so long as he keeps the supply of wheat in hand, can fix the prices that shall rule the market.

Hence it seems probable that only a very small inducement would be necessary in order to cause buyers to secure delivery of the corn to the United Kingdom some months before it was consumed, rather than, as at present, to live from hand to mouth (*Q.* 816).

The question is, how this inducement is to be supplied. There seem to be four possible ways of doing this :—

(1) To encourage storage by some system of bounty, or gratuitous storage by Government.

(2) For the Government to store and deal in wheat.

(3) To make it obligatory by law for imported wheat to be stored a certain time before being consumed.

(4) To levy a tax on imported wheat which is not stored for a certain period.

It is the last of these modes I would suggest for consideration. In order to carry it out I suggest that an import tax of, say, 4*s.*, might be levied on imported corn and flour; but if the importer would bond his corn he should not be obliged to pay the tax till he took the corn out of bond, and then only to pay a tax reduced, say, by 1*s.* for each month it had been kept, so that if he kept it four months he would pay no duty at all.

It is obvious that these figures have been adopted as a conjecture. Other figures and periods might be more suitable. But it seems probable that the fact that a vendor who had stored his wheat would have a 4*s.* advantage over one who had not stored his wheat would be a sufficient inducement.

The suggested advantages of this scheme are :—

(1) That it would check the danger of foreign wheat corners (*Q.* 1108, 2071).

(2) It seems probable that grain would be stored in preference to flour. In this case the milling industry would profit, and we should have the advantage of the offals.

(3) It involves no new administrative departure, for the methods of levying taxes on corn and bonding are perfectly understood. There is no danger of smuggling, and as corn is large in bulk in proportion to its value, there would be no danger of surreptitious removal. The stores would all be large, because size would promote economy in handling, so that supervision would be easy.

(4) It does not involve the Government in the purchase of grain or the building of stores or the sale of grain, together with all the attacks and misunderstandings to which Government dealings in articles of common consumption give rise (*Q.* 1390).

(5) It does not involve the keeping of wheat for any periods longer than those for which it is kept already (*Q.* 857-861).

(6) If wheat is to be kept, it is preferable that it should be some good keeping kind of foreign wheat, such as hard Canadian or Australian wheat, rather than British wheat, which does not keep so well.

(7) Almost any method of bounties on storage of imported wheat involves the expenditure of a considerable yearly sum of money; but there is good reason for thinking that a very small inducement ought to turn the scale in favour of British storage.

Therefore, everything given over this would not only be thrown away, but worse; it would act as an encouragement to the foreign wheat importers and a further discouragement to the British farmer, already hard-hit.

Whereas, on the contrary, a tax, in so far as it operated at all, would on the one hand be a gain to the Exchequer, and on the other hand an encouragement to farming industry.

But I greatly doubt whether under this proposal any tax would be paid. It seems probable that importers would prefer to store the wheat rather than pay the tax.

A tax is a better plan, I think, than absolute compulsion to keep the wheat, because under a tax, if prices are high, the storage automatically relieves itself and tends to steady prices.

I can easily understand, of course, that those interested in the grain trade would naturally incline to some scheme of bounty on storage, but the general consumer may be expected not to view the scheme so favourably, and to ask why we should pay people for keeping wheat in the United Kingdom when the evidence shows that it costs no more to do so than to keep it in America.

This proposal is, of course, not contrary to Free Trade principles, nor protective in its character. Any advantage it gives to the British wheat-grower is incidental. It might be asked: "Will this scheme diminish the amount of wheat imported, or will it raise the price ?"

With regard to the first question, the statistical appendix to the evidence of this Commission, p. 95, shows that a rise in price has very little influence on the amount consumed.

With regard to the second, it could not raise it by more than the extra cost of storage in the United Kingdom, of, say, 10,000,000 quarters over what the storage of that quantity of wheat would have cost in America.

We have evidence that this extra cost of storage ought to be very small, for it is as cheap to store wheat in the United Kingdom as in America. Even if the extra cost of storage came to 1*s*. per quarter on the amount stored the advantage would be that, instead of having to levy taxes to pay it, by the suggested scheme it would pay itself, partly out of the pockets of the British consumer, partly (as all import duties do) out of the pocket of the foreign producer, while any rise of price it caused in wheat would accrue to the benefit of the farmer, as well as of the revenue.

It therefore appears to be the cheapest mode of attaining the object.

There seems to be little doubt that money would be forthcoming to build proper stores. Some existing stores are falling into disuse, owing to the decreasing amount of corn stored in the United Kingdom. Any scheme of home storage involves the coming into existence of stores, whether under the compulsion of a tax or the inducement of a bounty. H. H. C.

Upon this proposal the majority of the Royal Commission reported as follows:—

MR. CUNYNGHAME'S PROPOSAL.

In addition to the proposals examined above, a scheme has been laid before us by one of our number, Mr. Cunynghame, the aim of which is, by certain fiscal arrangements, to cause wheat to be stored in the United Kingdom rather than in the country of production. With regard to this scheme, we find that, so far as concerns expense, it is certainly more economical than any in the preceding classes, for it entails practically no charge on the revenue except that of collecting the tax, and if any considerable proportion of imported wheat paid the tax rather than go into bond, the plan would soon be self-supporting. It also has the merit of simplicity. Moreover, it should certainly act as a means of steadying prices; for if prices rose by more than 1*s*. per quarter, the rise would bring into the market all the reserve which had been in bond three months, and on which the merchant could now afford to pay the remaining 1*s*. tax and still make a profit. If prices rose more than 2*s*. per quarter, it would automatically set free the reserve which had been in bond only two months, and so on, a process which would, of course, tend to reduce prices to their original level. If the reserve were inexhaustible, the more prices increased the more wheat would be thrown on the market, and the result would be all that could be desired; but Mr. Cunynghame has mentioned four months as the period during which imports would have to be bonded in order to become free of duty, and it would scarcely be possible to extend the time much beyond that point, so that the maximum amount in store at any given time could not be more, and would probably be a great deal less, than 10,000,000 qrs. As a rise of 4*s*. per quarter is not an abnormal amount in the fluctuations of wheat prices, and as in the period preceding an outbreak of war prices would almost certainly rise beyond that point, it is at least a possible contingency that importers would be tempted to sell out their reserve at once, with the result that when war actually broke out it might conceivably all have vanished. In fact, it is one of the chief disadvantages of Mr. Cunynghame's scheme that the maintenance of the reserve at any given quantity could not be made certain and the scheme might easily be rendered abortive from the point of view of food supply in time of war, unless some restrictions as to sale were placed upon holders of the stock, in which case, of course, it would

be necessary to offer them some compensation. We should add that Mr. Cunynghame has explained that it is not of the essence of his scheme that the tax should be 4*s.* per quarter. Any sum, even 1*s.* per quarter, would be enough that would act as an inducement to the storage of wheat in the United Kingdom.

We are also afraid that the scheme would cause a certain amount of disturbance to the corn trade. For example, it would presumably do away with all dealing ex quay or ex ship, if the storage in this country became obligatory, and it seems probable that the system of sending wheat on consignment would also have to be discontinued if it became universal to bond wheat for the four months; for it is not likely that a foreign owner would agree to hold his wheat in store in the United Kingdom, seeing that by so doing he would restrict his choice of market and make himself dependent on the price ruling in the United Kingdom at the end of the four months.

A practical difficulty in working the scheme also occurs to us. Wheat arrives in this country in varying degrees of condition. In some cases it may be expedient to pass it into consumption without delay, but it is obvious that if this scheme were in operation, that could not be done without the payment of 4*s.* per quarter, an amount which would clearly be prohibitive.

There is the general argument in favour of all schemes and proposals for permanently increasing the stocks of wheat held in this country, namely, that they will probably operate to the detriment of speculators who may be endeavouring to raise prices, whether by cornering or by trade rings and arrangements. One of the reasons why wheat is kept in America rather than shipped to England undoubtedly is the advantage it gives to the grain exporter in controlling prices. The very fact that the wheat is in the country of consumption prevents the fear of its being diverted from its destination, and thus aids in steadying prices. There can be no greater preventive of possible corners and violent fluctuations in the United Kingdom in time of war than an increased permanent stock at home.

I do not know whether the authors of this criticism considered it as condemnatory of the proposal. To me it seems that their remarks only strengthen and emphasise the points for which I was contending.

I need not, I think, further explain this proposal, which is, of course, intended for adoption, not during time of war, but during a time of peace in preparation for war. It might be accompanied by the erection of public granaries as at Chicago, or their erection might be left to private enterprise. The securing of the work of aërating the grain, of milling it, and of using what is called the "offal" or husks for feeding cattle, would alone employ a considerable number of men, and would be of great benefit to farmers.

Granted that some inferior grain came over which would not keep, it could be released by special order and on special terms, and would still be very valuable feeding-stuff for stock and poultry. This offal amounts to about 30 per cent. of the corn, and of it only about 2 or 3 per cent. is sheer waste.

I can only ask why we should permit, and even encourage, a system which secures a food supply in time of war to America instead of to Great Britain, which secures the industry of handling the corn to Americans instead of to Englishmen, which provides the American farmer with the offal of the flour paid for by the people of Great Britain, and which is used by speculators as a means of livelihood at the expense of the consumers of this country.

We cannot produce and consume wheat simultaneously, as, for example, we produce and consume coal. Corn only comes in at the harvest, at one time of the year. Storage is, therefore, a necessity in the case of wheat, whereas it is not a necessity in the case of coal.

It costs no more to store the wheat here than abroad. Why, then, are we to allow speculators to keep it in America merely in order that they may be enabled to engineer the markets to their own advantage?

I use the word "engineer" not wholly in a bad sense. Legitimate engineering of the market may in some cases result in producing uniformity of prices by anticipating falls of price as well as rises. "Buying forward" is quite a legitimate operation. But where those engineering processes involve grave danger to the very existence of our country it is the duty of Government to guard against them, especially when they tend not to lower the prices of the staple commodity of life but to raise them.

Even, however, if it were admitted that the conclusions of the majority of the Royal Commission were right in 1905, and that the minority was wrong in dissenting from them, yet that report needs reconsideration to-day.

It was made upon three assumptions:—

1. That the British Navy would be kept up

on the two-nation power standard. This condition is expressly laid down (see par. 130, p. 30).

But the two-power standard no longer exists.

2. Again, the report assumed that the principles of international law would most probably be observed by our enemies (par. 113, p. 26), and enforced by neutrals (par. 111, p. 26). They have been openly violated by Germany, and neutrals, even including those whose rights have been violated, have merely protested but declined to intervene.

3. The report was made on the assumption that captures at sea would be made in the then recognised methods (par. 146, p. 34). Those who signed it did not contemplate the use of submarines without warning against merchant vessels. Unless this war shall result in the formation of a *defensive and offensive* league of humanity in war and a restitution of our Navy to the position of relative superiority that it possessed in 1904, the conclusions of the report cannot be supported. I do not believe that the majority who then voted for them would consider those conclusions applicable to the present state of affairs.

The only two proposals that met with favour at the hands of the majority or minority were some scheme of free storage, and that which I submitted. Both would be useful, but on the whole, after comparing them, I still prefer my proposal.

The free storage scheme only offers free rent, the advantages of which to the corn merchant vary from 6*d*. to 1*s*. 6*d*. per quarter of corn per annum, according to various estimates or schemes.

I doubt whether this would be sufficient to induce the speculator to give up the advantage he obtains by storing the wheat in America. The advantage he obtains from engineering is too great to be foregone for so small a benefit, especially as under the free storage scheme he would himself have to pay the remaining costs of storage in Great Britain, such as aërating, carting and inspecting, which might be greater than what they now charge him for the same services in America.

But according to my plan, if he does not store in Great Britain at all, he loses 4*s*. a quarter right off, whereas if he stores for half the year, or such period as shall be considered reasonable, he loses nothing at all.

Of course, my plan might be combined with the provision of a public granary conducted under Government supervision and at cost prices. Such work as this could perfectly be done by Government-paid servants, being a matter involving no speculation, no risks of the market, no duty of estimating future prices, but merely efficiency of a purely routine character, and might well be done by our soldiers in time of peace.

Lastly, the plan does not involve the abandonment of "Free Trade principles." It might be combined with Free Trade, or with a protective tariff.

Even if it were a form of Protection, why should we, in levying our import taxes, select coffee, sugar, tobacco and things that we do not ourselves produce, apparently expressly in order that any incidental advantage which might be obtained from the protective action of the taxes may not be obtained for English producers by ourselves?

It may be good morals for the governors of a charity to refuse to receive funds derived from a bazaar lottery, on the ground that they cannot countenance gambling, or receive money from a tainted source, but surely protection of native industry, whether wise or unwise, is not on a moral level with State gambling. Nor can we say that protection of trade is so poisonous that we ought rather to risk national starvation by an enemy than resort to it.

What if the agricultural labourer and farmer profit a little by a scheme designed to promote national safety? Are agricultural wages and profits so high that there is no need to consider the interests of the agricultural classes?

Are the industrial classes so selfish that every Act of Parliament must be in favour of industry and against the interests of agriculture? Even at the worst, suppose the scheme failed, and that no foreign corn was stored in Great Britain, a tax of 10*s*. a quarter on imported corn would cause at least 15,000,000, qrs. of corn to be grown in Great Britain, instead of 7,000,000, and would bring in a revenue of about £7,000,000 sterling of money, besides benefiting agriculture and giving us a secure food supply in case of war. It is difficult to compute what the loss would be, because against the rise in home price there would have to be put the advantage of increased agricultural wages and the wages obtained from handling and storing the corn. In any case, it would be a cheap investment if it secured a constant minimum supply of wheat for six months' consumption.

But, for the reasons stated above, I do not believe the scheme would fail. There are no

intrinsic difficulties against storage of corn in this country, where means of communication are good both by land and water, where mechanical appliances are to be obtained, and where labour is certainly not dearer than in America.

There are two further objections which I mention, because they were made to me at the Commission by two of the members who signed the majority report.

One of them said that it would be a bad plan to have a security from starvation, because the people would then never vote the money necessary for a strong fleet, and that this feeling of security would lure them to destruction. He even went on to deprecate the spending of money on an army. "We are a maritime nation," he said; "if our Navy is beaten we are done." The other said that a provision of food for the eventuality of war was useless, because the working-men of Europe would take care that there never was another European war.

Comment on these opinions is needless. By the mercy of Providence, and in spite of the most determined refusal to look facts in the face, we have probably escaped from a serious calamity. It is to be hoped that when the opportunity comes we shall not again risk our national existence by refusing to take the most obvious precautions for our safety.

DISCUSSION.

The Chairman (Captain Bathurst, M.P.), in opening the discussion, thought that while the author's scheme would afford the country much greater security than it enjoyed under existing conditions, it would be well to supplement it in some very material respects. He thought Sir Henry had over-estimated the amount of food which came to Great Britain from overseas. Something like five-sixths of our bread-stuffs before the war came from abroad, but very nearly half of the meat consumed was produced in the country. He entirely agreed with the author's statement that it did not seem probable that the price of wheat would ever again fall so low as it was in the first years of the present century, but he ventured to add that it was not well it should, because it threw land out of cultivation and rendered our position extremely precarious in time of war. He had never been greatly convinced by the report of the Royal Commission; in fact, he thought the author's scheme was the most convincing part of a report which was inconclusive and somewhat lacking in courage and definiteness. The proposals in the report were in effect whittled down to two: first of all that there should be a national indemnity, contrasted with national insurance against loss or capture by the enemy; and, secondly, the offer of storage room rent free for wheat in this country, whether produced here or overseas. It was interesting to note that the reason a national indemnity was advocated, as compared with national insurance, was owing to the desirability of keeping the rates of freight as far as possible at a normal level. What an interesting commentary the rates now being paid were upon the forecast of the Royal Commission! He did not think it was an exaggeration to say, looking at the actual facts which the war had brought to their notice, that if the German Fleet had not been penned in German waters by the British Fleet at the outbreak of hostilities, and if German submarines had been twenty times as numerous, not to mention the activities of an increased number of Zeppelins, the dread of starvation would long before this have finished the war to England's discomfiture and shame. Those conditions, he suggested, were bound to prevail in any future war, and if so they were conditions against which it was but common prudence to provide. An indemnity granted by Government to food-carrying ships would not ensure those ships reaching our shores, although it would encourage the shippers to run greater risks. The only really safe course was the greater production of food at home. Under the author's scheme the bulk of the food would have to come from overseas, and any enemy this country had to face in the future would make every effort to prevent its reaching our shores. Increased production at home must depend upon definite Government encouragement and protection. Thirty years ago Bismarck, who had proved to be a true prophet and a true constructive statesman in many respects, said: "There is no greater national calamity than for wheat to fall below a price at which farmers can produce it at a profit." For a long series of years following the commencement of the great agricultural depression wheat was grown at a loss, with the result that wheat production was greatly reduced, and this country had to depend to a greater and greater extent upon foreign supplies. In 1892 wheat fell to 22*s.* 6*d.* a quarter, and at one period in his own part of the country the price of straw was more than the current local price of grain. He believed Bismarck was right, and that it was in the highest national interest to take care that wheat could be grown in this country at a profit, if it was only a bare profit, so as to put some sort of premium upon its production by British farmers, which would be a great factor in increased security. He had for many years advocated a bonus or bounty on the part of the Government as an inducement to both large and small farmers to grow more wheat. He suggested in a pamphlet, which he wrote four years ago, that that bounty might be the difference between 35*s.* a quarter and the current market price of good sound wheat. He further estimated that on the basis of the seven previous years the amount the Government would have had to provide at the most in any one year

would not have exceeded the cost of a Dreadnought, and the national security resulting would be infinitely greater than that provided by a battleship. Even the storage of overseas wheat in silos in Great Britain would not afford adequate security during a prolonged war. The author's scheme would no doubt serve all necessary purposes if the war lasted no longer than six months; but in a war of any greater length the greatest security was to be found in a largely increased home production. It was often said that it was quite impossible to double the present output of home-grown wheat. In that connection it was well to remember that wheat was grown much more intensively nowadays than it used to be, and much better varieties were grown. Thanks very largely to the experiments which had been translated into most valuable results through the Mendelian Research at Cambridge, wheats were now being largely grown by the best farmers in this country which, instead of producing 32 bushels to the acre, produced 40 bushels of 70 lb. as against the old English average of 60 lb. A good sample of Little Joss, which was a very popular Cambridge wheat, would probably run to 67 lb. a bushel. The Royal Commission evidently did not foresee that it would be possible in this country, as the result of the research, to grow wheats similar to those which had been raised in Manitoba and India, which possessed the baking qualities of the best of the wheats of other countries. Wheats of that character were in fact being grown in England, and although there was a lingering prejudice amongst millers against British wheats they had enormously improved during recent years. Farmers were always being criticised for not growing what the public was deemed to require, but it must be remembered that there was no industry more insecure than the agricultural industry, particularly in regard to arable husbandry, and yet there was none more vital to the nation, as war experiences were proving. One additional advantage accruing from the growth of a largely extended area of wheat was that it would be possible to avoid sending very large sums of precious money overseas in times of war to pay for wheat which came from abroad. He believed this country was paying for food from overseas something like £300,000,000 a year at the present time. They ought to be able to keep at least £150,000,000 of that in this country if greater encouragement were given to the home production of food. When the war was over the country would be almost bound to develop the production of sugar on British soil, and if that was the case the valuable residues which resulted through the growth of a crop of sugar beet would be a great encouragement to the extended cultivation of all cereal crops, particularly wheat. Whereas after the war wheat would still continue to be the chief British crop, he was not at all sure that sugar beet would not become the farm crop of second importance only in this country. The other members of the Royal Commission, in criticising Sir Henry's scheme, suggested that it would produce considerable disturbance to the corn trade. Personally he could not conceive of its producing a greater disturbance than that which had been caused since the war began by the Government purchase of wheat, very often in large quantities, without any warning to farmers and millers, creating enormous disturbances in the markets throughout the country, and causing sometimes a fall in the price of wheat of no less than 10*s.* a quarter in something like the same number of days. That could not be a healthy condition of affairs. He was glad to notice that towards the end of his paper the author asked why it should be considered a crime to afford some measure of prosperity to the agricultural classes. He thought that by now it must be fairly demonstrated, as the result of the war, that a greater measure of prosperity must be provided for the agricultural classes. It was quite certain that the agricultural labourer was going to obtain substantially larger wages after the war than he had done before, and that would only be possible if the products of the farm fetched a higher price. Although no doubt the cry of the demagogue in favour of cheap food was very attractive to the populace, he could not conceive any more delusive cry, or any cry that was more likely to land the country in difficulties in times of national crises. It was not to the nation's interest that food should be sold at a less cost than that at which it could be produced in the country. He was afraid it was always suggested that any schemes that would benefit the agricultural industry would give an unfair benefit to the landowner. Personally he thought it was quite possible to devise a scheme which would limit the advantage to be derived by the landowner. It would be a very good thing if the landowner did derive some benefit out of any such scheme, because it would be a far greater inducement to him to be more genuinely personally interested in the development of his own land, and the promotion of the greatest British industry upon that land, than he was at the present time. The tendency of the policy of all Governments for many years past had been to convert the landowner into a mere rent-receiver instead of being, as he ought to be, the managing director of a great industrial business.

The Right Hon. J. Round thought the war had proved that it was extremely important for the nation to produce more food in the future than it had done in the past. The Chairman's statement that £150,000,000 per annum might be kept in the country by the production of more food at home was an exceedingly important one, which he hoped would be widely considered.

Mr. A. E. Humphries (Past-President of the Millers' Association) said the author had stated

that about five-sixths of the food consumed in this country came from abroad, but Mr. Rew, of the Board of Agriculture, in a paper read before the British Association in the previous year, had stated that it was only one-half. Most people, when they referred to the proportion of food produced at home, dealt almost entirely with wheat production. It was a fact that this country did not produce at home more than 20 to 25 per cent. of the wheat it required, but taking the whole of the food of the country he agreed with Mr. Rew that it produced approximately one-half. The author had suggested that when wheat was brought into the country it should be stored for four months, but that in certain cases it should be used for consumption forthwith. That was an absolutely necessary provision, because even in Manitoba snow had occurred during harvest-time, and great difficulty had been experienced in keeping the wheat. North Russian wheat contained 17, 18, and 19 per cent. of water, and in such cases the wheat would not keep. The author said that English farmers did not possess facilities for storing. If Sir Henry referred to granaries he agreed, but if he meant that English farmers could not store wheat satisfactorily he profoundly disagreed with him, because it was impossible to store wheat in a better manner than in ricks. The amount of damage done by rats the farmers could, to a large extent, prevent. English wheat, which was in a physical state unfit for use soon after it was harvested in a bad season could, by the succeeding May, June, or July, after it had been properly stored, come out perfectly fit for food, and English millers were only too willing to pay good prices for it. The author had referred to the great advantage that would accrue from the millers grinding the wheat in the United Kingdom so that the offals could be used in the country. He agreed, but he wished to point out that only about 10 per cent. of the flour consumed in the United Kingdom was imported. Since the Government had stopped the export of offals, the whole of the offals made at home were kept in this country, and they represented within 10 per cent. of the possible maximum. He did not feel at all hurt at the "chipping" merchants and millers continually received. It was often thought that in pre-war times millers and merchants made a great deal of money, but that was not the case. The amount of profit upon the transaction was incredibly small. A huge volume of business was done on an extremely small margin, and that was the reason the trade was driven into big concerns. The trade was an extremely hazardous one, in which sometimes huge profits and sometimes huge losses were made, and when the two were balanced only a small and reasonable profit remained. He agreed with the author that what had happened in the past had to be revised in the light of what was now happening, but although there was a case for investigation, the members must not run away with the idea that the British public was being "bested" or "done" by the corn trade.

Mr. W. T. Chadwin said that wheat had always been referred to as if it were the one food product upon which this country was dependent. He contended that commodities should be sold at such prices as would prevent waste, and if the working-classes could buy bread at 6*d*. a loaf they had no right to complain. That would enable the price of wheat to be kept in this country at about 45*s*. a quarter, and under those conditions there would be no hardship to the consumer of bread, and an inducement would be offered to the farmer to enable him to increase his arable cultivation at a profit. One means that tended in that direction was the cultivation of sugar beet. Had a sugar-beet industry been started in this country in years past, the system of agriculture would have been immensely improved thereby. In his opinion it should be the basis of an improved agriculture. The sugar beet should be followed by corn crops, and there was ample evidence to show that thereby the produce of the land would be increased by 25 per cent. A much larger number of cattle could be reared on the land and the whole welfare of rural England would be improved; it would be possible to pay higher wages, to house the agricultural labourers better, and the spending power of the community would be increased.

Mr. W. J. Paul (Ipswich) thought the paper was too narrow in its scope, as the author had not realised the great importance of the importation of cereals into this country. The production of cattle and the production of wheat were so intermixed in this country that the one could not be touched without interfering with the other. The Government was guilty of a most lamentable error of judgment at the present time in prohibiting English vessels loading more than 25 per cent. of anything else but wheat. As a consequence, cereals required for feeding cattle in this country had risen to such a point that ordinary maize was selling at the present time at the same price as English wheat. If that state of affairs continued only a very little longer, English wheat would go into the mouths of pigs instead of human beings.

Mr. C. P. Ogilvie said he did not think the paper went far enough, as wheat could not be separated from the other cereals. Linseed was of the greatest importance in that connection, and if prices rose much higher cattle would be eating the food that the Government had bought to protect the people of this country from starvation. Linseed and maize were just as important to the country as wheat, otherwise there would be a shortage of food in the shape of beef. There had been a large decrease in the amount of wheat and frozen meat imported into this country from Argentina since 1908, but he believed that the decrease, so far as the wheat was concerned, would be greatly made up by the intelligence possessed by the farming industry of this country. England could not boast of what she had done in

the past in regard to agriculture, and a great deal remained for her to do in that direction.

Mr. W. F. Giles mentioned that in the north of England and in Scotland very little permanent pasture was to be seen, the land being almost entirely arable, and a tremendous number of bullocks and sheep were reared. It would be of interest to know whether in the author's opinion a similar system could be adopted by the farmers in the south. An extraordinary amount of manure was put on the land; the crops grown were chiefly root crops for the feeding of the bullocks, and the labour was well paid. He believed that in the grass rotation the land was put down to grass for one year, or at the most two years, a very strong-growing kind of clover being sown, and some giant Italian rye grass. It was rare in Northumberland to see any great areas of land down to permanent pasture, and yet at the same time large areas of corn were grown. If a similar system could be adopted in the south he thought it would help to keep up the food supply of the country.

Mr. Walter F. Reid said that the author had referred only to wheat. One important food, namely, the potato, had been omitted altogether. A much larger quantity of food in the shape of potatoes could be grown on a given surface of land than wheat. He differed in the conclusions drawn by the author as to the advantages derived from storing wheat in this country compared with America. The miller preferred to have the corn stored for a long time in a dry climate like America, rather than to have it sent over to this country in its moist state. Potatoes had been the standby of the Germans during the present war. Their bread tickets would have been useless to them if they had not possessed an enormous supply of potatoes. He thought the object aimed at by the author would be attained not by the storage of imported wheat but by producing either wheat or other food material ourselves in the country. He deprecated continual adherence to wheat as a food. He lived for many months without eating any wheat food and was much the better for it. Education in the use of different kinds of food was of the utmost importance. The growth of sugar was undoubtedly an advantage to agriculture, but whether it was an advantage to the food supply of the country was another question. The chief advantage from the national point of view of growing sugar beet was that practically every element that was taken out of the land—the potash, the manure, and everything else—went back again, except what was given to the cattle. An excellent substitute for sugar existed in this country in the shape of honey. Since sugar has become scarcer the demand for honey had enormously increased, and the output of honey could be multiplied indefinitely without a single extra acre of land being used. The bee-keeper obtained his honey from his neighbours' crops, and did not use a yard of his own land for producing it.

The Chairman, in proposing a hearty vote of thanks to the author for his most interesting paper, hoped Sir Henry would not be discouraged by the few words of criticism that had fallen from some of the speakers; the question must be regarded simply from the point of view of national security. If any injury was done to any trade it was not justifiable except in the highest national interests, and he could not conceive that the millers of the country were destined to suffer in any way under a reasonable application of the scheme which the author had put forward. He suggested to Mr. Reid, as a chemist, that unless the potato was eaten in its jacket it would be hardly so nutritious as bread that contained the germ and the skin of the berry. If education on food values on the lines Mr. Reid suggested was given, much of the very white bread that was eaten would be discarded, and perhaps also some of the rather carelessly skinned potatoes that formed a very small portion of the British diet.

The resolution of thanks was then put and carried unanimously.

Sir Henry Cunynghame, in reply, said he entirely agreed with the remark that had been made that much the best way to deal with the subject was to grow, if possible, enough food of all kinds at home to make the country quite secure in case of war. But it must be remembered that for many years to come this country would be dependent on foreign countries for food supplies to a considerable extent, and the main suggestion contained in the paper was that, if the country depended on foreign supplies of wheat, those supplies should be kept in this country instead of in America. That would make the country secure for eighteen months or two years instead of only five weeks, as at present, and even that was something to the good.

Sir Graham Bower writes:—I greatly regret that my health—I am slowly recovering from a bronchial attack—will prevent me from hearing the paper by Sir Henry Hardinge Cunynghame on "Supply of Food in Time of War," for it is a subject in which I have for some years taken an interest. Various solutions have been proposed, but all are open to objection. A Government store of corn is open to two objections—(1) that it involves a lock-up of capital during peace in the shape of the storage of goods that deteriorate, and (2) the knowledge that large Government stores might be thrown on the market would discourage private importations. With reference to a Government subsidy to private merchants, the tendency of modern commerce is in the direction of small stocks and a quick turnover, for large stocks mean idle capital. The proposal of a subsidy to merchants to keep two months' stock in hand is

at first sight tempting, and is actually in force in the case of the Frozen Meat Company of the Island of Mauritius. But on closer examination practical difficulties present themselves, and such a subsidy must necessarily carry with it a stipulation as to price—a very difficult question. The cultivation of waste places is a newspaper folly. As president of a farmers' club, which includes four hundred farmers, I can say that every waste place that we know of is put to the best use to which it can be adapted, and that anyone who was fool enough to sink money in the cultivation of waste places would soon ruin himself. Even the county councils, who are not famous for wisdom in the purchase of land for small holdings, have sense enough to keep clear of waste places. A minimum price of corn has been suggested by Lord Milner's committee. But this is another folly, as any agricultural economist can certify. A high price of corn is fatal to the existence of the small-holder, who can only live as a fruit farmer, market gardener, or dairy farmer. To all these cheap feeding-stuffs are a necessary condition of existence, and a minimum price of corn would exterminate the small-holder just as the rise in the price of corn killed the yeoman farmer in the latter part of the eighteenth century. I do not even discuss what the town artisan would say to such a proposal. There remains therefore the traditional British policy, which may be described as Free Trade and the Blue Water school. This has been our policy, and appears to have been justified by results. For (*a*) Food is cheaper in England than in any of the belligerent countries; and not only cheaper, but more plentiful. (*b*) Since the outbreak of war, four of the belligerent nations —France, Italy, Austria, and Germany—have been forced to adopt the policy of free importation of food. (*c*) The protective duty on food has not made food more plentiful in the protected countries. On the contrary, it has been scarcer than in England. I would have been glad to have heard Sir Henry Hardinge Cunynghame's views, and to have compared them with those I have formed, but that is not possible.

GENERAL NOTES.

Export of Phosphates from Tunis.—According to the statistics published by the *Direction générale de Finance*, Paris, the total quantity of phosphates of lime exported from the Protectorate of Tunis in 1914 amounted to 1,427,162 metrical tons, of the value of 32,824,719 francs (£1,312,789 sterling). This is 28 per cent. loss, as compared with the quantity exported in 1913. The chief ports for the shipment of this substance were Sfax, which alone exported 61 per cent. of the above quantity, Tunis and Soussa. 28 per cent. of the exports was shipped to France, 29 per cent. to Italy, 14 per cent. to Great Britain, 7 per cent. to Germany, 5 per cent. to Holland, 4 per cent. to Spain, and the remaining 13 per cent. to ports of eight other countries. As regards nationality of vessels engaged in this trade, 26 per cent. were Italian, 18 per cent. French, 11 per cent. British, 10 per cent. Greek, 11 per cent. Danish, and the remaining 26 per cent. under other flags. It is anticipated that the results for 1915 will be greater than those of the preceding year, notwithstanding the war and the scarcity of labour which has been felt throughout the country. The shipments from the two principal deposits of phosphates, viz., those of Kalaa-Djerda and Gafsa, are reported to be very considerable at the present time, the former being not less than 25,000 tons, and the latter 91,000 tons per month.

Oil on the Grand Trunk Railway.—The Grand Trunk Pacific Railway (according to the *Canadian Gazette*) now uses oil on 700 miles of its track in Western Canada. To make this possible the company had to complete and set up oil plants at Jasper, McBride, Prince George, Endako, Smithers, and Prince Rupert, B.C. Economy and the elimination of smoke and the greater safety of the forest ranges near the line are the advantages of oil fuel.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

May 10.—Sir Francis Taylor Piggott, M.A., LL.M., Chief Justice of Hong-Kong, 1905–1912, "Neutral Merchants and the Rights of War." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

May 17.—George Percival Baker, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe." Sir William Martin Conway, M.A., F.S.A., F.R.G.S., will preside.

May 24.—John Collett Moulden, A.R.S.M., M.Inst.M.M., "Zinc, its Production and Industrial Applications." (Peter Le Neve Foster Prize Essay.) Dugald Clerk, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

Indian Section.

Thursday afternoon, at 4.30 p.m.:—

June 1.—Professor Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S., "The Work of

the Imperial Institute for India." THE RIGHT HON. LORD ISLINGTON, G.C.M.G., will preside.

JUNE 23 (Friday).—SARDAR DALJIT SINGH, C.S.I., "The Sikhs."

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m. :—

J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

Syllabus.

LECTURE II.—MAY 8.—*Waves in Ponderable Matter.* Transverse and longitudinal waves in solids and liquids—Methods of production and propagation—Polarisation—Wind waves—Ship waves—Tides and seiches—Cloud waves—Independence of wave trains—Superposition of harmonic motions—Sound waves—Submarine bells—Voice, phonograph, and gramophone.

LECTURE III.—MAY 15.—*Waves in the Ether.* Free and conducted—Light, heat, and electric waves—Alternating currents—Telephonic transmission—Wireless telegraphy—Submarine cables—Inductance, capacity, and resistance—Limits of known wave-lengths—Röntgen rays—Light—Heat—Reflection, refraction, and diffraction of wave motions—Stationary waves—Attenuation and distortion of travelling waves.

LECTURE IV.—MAY 22.—*Resonance.* Mechanical and electrical—Superposition of periodic impulses—Universal importance of the selective absorption of wave motions—Mechanical resonance or revibration—Screening of vibrations, absorption, and filtration—The acoustics of buildings—Sound resonators—Absorption of light waves—Coloured glass—Vision and photography—Absorption of electrical power by resonance—Tuning in telegraphy.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 8...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Dr. J. Erskine-Murray, "Vibrations, Waves, and Resonance." (Lecture II.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Mr. F. N. Keen, "A Scheme for the Development of Agricultural Land."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Mr. J. E. Stabler, "Travels in Ecuador."

TUESDAY, MAY 9...Faraday Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. 1. Mr. E. Hatschek, "An Analysis of the Theory of Gels as Systems of Two Liquid Phases." 2. Mr. F. C. Thompson, "The Properties of Solid Solutions of Metals and of Intermetallic Compounds." 3. Mr. F. C. Thompson, "The Annealing of Metals." 4. Dr. F. J. Brislee, "The Changes in the Physical Properties of Aluminium with Mechanical Work. II.—Specific Heats of Hard and Soft Aluminium." 5. Messrs. R. Seligman and P. Williams, "A Note on the Annealing of Aluminium." 6. Mr. Z. Jeffries, "Grain Size Measurements and Importance of such Information." 7. Mr. E. J. Hartung, "A Contribution to the Theory of Solution."

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. 1. Annual Meeting. 2. Discussion on the Report of the Research Committee.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. L. Binyon, "Chinese Painting.' (Lecture II.)

Brewing, Institute of, Trocadero Restaurant, Piccadilly-circus, W., 8 p.m. Dr. H. T. Brown, "Some Reminiscences of Fifty Years' Experience of the Application of Science to Brewing Practice."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Miss D. M. A. Bate, "On a Small Collection of Vertebrate Remains from the Har Dalam Cavern, Malta, with Note on a New Species of the Genus *Cygnus*." 2. Dr. J. C. Mottram, "An Experimental Determination of the Factors which cause Patterns to appear Conspicuous in Nature."

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Mr. A. Toynbee. "World Relations and World Organisation—the Racial Aspect."

WEDNESDAY, MAY 10...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Sir F. T. Piggott, "Neutral Merchants and the Rights of War."

Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Mr. W. L. Nash, "The Totemic Origin of the Egyptian Gods."

Geological Society, Burlington House, W., 5.30 p.m. 1. Dr. F. R. C. Reed, "Carboniferous Fossils from Siam." 2. Mr. H. G. Smith, "The Lurgecombe Mill Lamprophyre and its Intrusions."

Optical Society, at the Chemical Society, Burlington House, W., 8 p.m. Dr. G. F. C. Searle, "Apparatus Used for the Teaching of Optics at the Cavendish Laboratory, Cambridge."

THURSDAY, MAY 11...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m. Mr. T. F. Ordish, "Shakespeare's London."

Royal Institution, Albemarle-street, W., 3 p.m. Sir E. Ray Lankester, "Flint and Flint Implements." (Lecture II.)

African Society, Hotel Cecil, Strand, W.C., 7.30 p.m. Lieut.-Col. S. M. Pritchard, "Experiences in German South-West Africa."

FRIDAY, MAY 12...Royal Institution, Albemarle-street, W., 5.30 p.m. Dr. A. C. Benson, "Vulgarity."

Malacological Society, Burlington House, W., 7 p.m. 1. Mr. G. B. Sowerby, "Descriptions of New Mollusca." 2. Mr. T. Iredale, "Solander as a Conchologist." 3. Messrs. T. Iredale and W. L. May, "Misnamed Tasmanian Chitons."

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Dr. H. S. Allen, "The Latent Heats of Fusion of Metals and the Quantum Theory." 2. Mr. T. Smith, (*a*) "Lenses for Light Distribution"; (*b*) "The Choice of Glass for Cemented Objectives."

SATURDAY, MAY 13...Royal Institution, Albemarle-street, W., 3 p.m. Professor W. H. Bragg, "X-rays and Crystals." (Lecture II.)

Municipal and County Engineers, Institution of (N.E. District), Hull, 10 a.m. Mr. F. W. Bricknell, "Recent Municipal Works and Practice in Hull."

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FRIDAY, MAY 12, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

NEXT WEEK.

MONDAY, MAY 15th, 4.30 p.m. (Cantor Lecture.) J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." (Lecture III.)

WEDNESDAY, MAY 17th, 4.30 p.m. (Ordinary Meeting.) GEORGE PERCIVAL BAKER, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe." SIR WILLIAM MARTIN CONWAY, M.A., F.S.A., F.R.G.S., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

NINETEENTH ORDINARY MEETING.

Wednesday, May 10th, 1916; DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, in the chair.

The following candidates were proposed for election as Fellows of the Society :—

Baddeley, Miss Mary, 113, The Crescent, Denmark-hill, S.E.

Banerjee, J. C., 21, Canning-street, Calcutta, India.

Driver, Robert Manning, Cowley, Horsell, Surrey.

Madden, S. Wilbur, 76, Sparks-street, Rangoon, Burma.

See Teong Wah, J.P., 10, Balmoral-road, Singapore, Straits Settlements.

Thomas, Miss Harriet E., 48, Clark-street, Newport, Rhode Island, U.S.A.

The following candidates were balloted for and duly elected Fellows of the Society :—

Donelan, Dermot O'C., J.P., Regent Palace Hotel, Piccadilly-circus, W.; and Sylanmore, Tuam, Co. Galway, Ireland.

Phillips, S. Charles, M.S.C.I., 47, Cannon-street, E.C.

THE CHAIRMAN, in introducing the reader of the paper, said that Sir Francis was a very distinguished lawyer, who had a large experience of international law. His work for many years in the Crown Colonies, and also as legal adviser in preparing the Constitution of Japan, gave him a special right to speak on all international legal questions.

The paper read was—

NEUTRAL MERCHANTS AND THE RIGHTS OF WAR.

By SIR FRANCIS TAYLOR PIGGOTT, M.A., LL.M.,
Chief Justice of Hong Kong, 1905–1912.

The subject of "blockade" has many facets; the different points of view from which it may be studied are as variant as the twelve-times-told tale of Guido and Pompilia which, set together, make "The Ring and the Book." And so, in spite of having of late written much, I venture on this further study of it, and will endeavour to put before you what I conceive to be its evolutionary principle.

There is invariably accompanying war of arms and men a secondary warfare of wordy dispute between the belligerents and the neutral Powers. Like the bourdon which persists through the skirl of the pipes, diplomatic grumbling is heard through the din of battle; protests in respect of cargoes alleged to be wrongfully seized, of ships denied access to ports to which they allege they are lawfully bound, appear side by side with accounts of battles lost and won. Commerce thrusts itself into the teeth of war; neutral "rights," as the merchants insist on calling them, are for ever cramping the hands of the fighting men, and neutral Governments are perpetually endeavouring, with long-drawn argument, to shackle the full exercise of belligerent power. I hope I shall not shock this distinguished audience, many of whom, I am sure, are deeply versed in the writings of the jurists, when I say that, in the majority of cases, these "neutral rights" of commerce are but the very shadow of a dream.

Does it not occur to you as strangely singular that when two nations are fighting for their existence—I put no higher stake in issue—some other nation to whom the question in dispute is of no concern should be busily insisting that the commerce of its merchants is being disturbed? When the whole street is in an uproar the huckster cries his wares in vain. If the belligerents, or one of them, were setting the ideas of civilisation at defiance: if those notions of fair fighting which the world has accepted as the laws of war, were being flagrantly disregarded, then a protest from the neutral nations would be intelligible, for if those ideas are put in jeopardy they, too, must suffer. Or, if treaties to which the neutral nations are parties, whether for guaranteeing the integrity of a State, or for safeguarding those ideas on which the continued sanity of the world depends, then again a protest from the neutral nations would be intelligible. Or again, if such protest were based on material loss, as that the wanton destruction of some small State had greatly damaged the neutral traders' flourishing commerce, yet, though the standard were a lower one, the protest would at least be intelligible. But when such a protest is not made, when there is another protest of an altogether different nature, which must, were it regarded, fetter the action of one of the belligerents to the advantage of the other, which must limit the exercise of that vast engine of war, the Fleet—by means of which the command of the sea has been fairly won—then one pauses to wonder what the world is coming to. Yet again, if two neutral nations, such as Spain and Norway, whose merchants had built up a great and honourable commerce, were to find that commerce seriously impeded by a war waged across the trade-routes, that their vessels were damaged or sunk by reckless strewing of mines, or even delayed in the pursuit of their lawful avocations by continuous fighting, their protest that "neutral trade is free" and not to be interfered with by other nations' wars would, though perhaps not practical, at least be intelligible. But a protest under cover of this worthy old formula, that trade which is in no sense "neutral trade" within the true and simple meaning of the words must not be interfered with, that trade which deliberately runs counter to the means adopted by a belligerent for crushing his enemy must still be allowed to pass to him and maintain him in the fight, is a departure from that old tradition of war which, as I hope to show you, has always enabled the neutral merchant to be successfully countered in every step he has taken to supply the enemy with commodities which the belligerent has declared he shall not have. Such a protest would make the waging of war subservient to commerce. I maintain that war being what it is, and the issues of war being what they are, all commerce between neutral merchants and the enemy, whether it be direct or indirect, must be subject to the control of the belligerent—such control, that is, as he has the power to exercise at sea. If he has lost that power the battle is half lost too, and it cannot be re-won by whining appeals to a neutral Government to violate its neutrality.

Let me admit at once that what we call International Law has not as yet formulated this as its ultimate proposition; but as to its soundness as a proposition of belligerent ethics I have no doubt whatever. Like all other ultimate propositions it is *in græmio*, awaiting the occasion for coming to the birth. The occasion is with us now; for not till this War did we know the full extent of the mischief of which the neutral merchant is capable, nor with what insistence he would press for the enjoyment of what he asserts to be his "rights," on which that power for mischief depends.

This is, and is alone, the issue between the Allies and the Neutral Nations. The Order in Council of March 11th, 1915, declared that all commodities going to Germany, either direct or indirectly through neutral countries, would be seized and dealt with as by the Order provided. "All commodities" include not merely absolute contraband, but conditional contraband, and non-contraband. The United States, in its Protest of April 2nd, 1915, championing the cause of the Neutrals, claimed that "innocent shipments may be freely transported to and from the United States through neutral countries to belligerent territory, without being subject to the penalties of contraband traffic or breach of blockade, much less to detention, requisition, or confiscation." Seeing that "innocent shipments" are intended to include everything except contraband of war, to which alone it is contended that the doctrine of "continuous voyage" applies, I think I have not overstated the case.

The position of a belligerent towards the neutral nations, as it is commonly understood, is a curious tangle of circumstances which has produced many strange theories; for each nation is in turn neutral and belligerent. When it is neutral its merchants strive to serve two customers; but when it is belligerent the

Government seeks to be on the best terms with those very merchants whom it makes it its business to thwart in their dealings with the enemy. It was, therefore, not to be expected that any very lucid statement of principles could emerge from the clash of such mutable interests. It certainly put the neutral merchant in a very dominant position, of which he has not been slow to avail himself; that position has determined the tone of the American protests to the Allies. Moreover, the attempt to reduce something in the nature of principle to writing has generally been undertaken in times of peace, when the theorist comes into his own. He has always sought to govern the action of a belligerent towards neutral merchants by juristic principles, and encumbers the subject with a series of cut-and-dried propositions. As the years of peace succeeded the writings grew and grew, till the great War came and realities stared us in the face.

The thesis of this address is that the action of a belligerent towards neutral merchants is governed by belligerent principles, tempered by discretion, and that the "rights" of the matter are only to be ascertained by reference to the play of elemental forces which war sets in motion. I have stated the nature of the claim about which the projectiles of diplomatic warfare are flying, but I want to put it once again in quite bald non-juristic language. The American merchant claims to supply to the enemy, with the assistance of other neutral merchants, commodities which the belligerent has declared he shall not get; "with the assistance of other neutral merchants," because he knows that if he attempted to supply them to the enemy direct he would meet short shrift, and would at once confess himself beaten in the unequal contest of merchantmen against blockading cruisers; and, to use his own language, the belligerent would be within his rights.

War lets loose upon a suffering world two opposing elemental forces: to use the jargon of the day, the "will to profit" and the "will to win." The conflict of these forces pervades the whole subject; and you will see how always the "will to win" has won. As belligerent power has triumphed over commercial activities in the past, so it will triumph in this last struggle which is impending—for, believe me, commerce is in its last ditch. And it will triumph because —I hesitate to use the word, but there is no other—because the belligerent is in the right. Let me explain why I use it in this connection. We believe, as I shall show you presently, that there is a standard by which international disputes can be settled, and that it is the same as that by which ordinary disputes between man and man are settled. Civilised nations have created Prize Courts for the decision of disputes between neutral merchants and the belligerents. They are courts set up by the interested belligerent himself, and so they violate in principle that fundamental canon of administering justice, that no man should be judge in his own cause. And yet the nations who are on the side of civilisation have taken a pride in appointing the best men to do this justice. It remains to their everlasting credit that the reputation for being a good Prize Court judge is the greatest a judge can seek; and there have been many very great in the continents on both sides of the Atlantic. The Prize Courts are the guardians both of neutral rights and of belligerent power, and in the past have held, and in the present they now hold, an even judgment, and many are the cases which have ended in an order for restitution of the vessel. It may surprise some to hear that the "Springbok" and the "Peterhoff" were thus released.

The weapon by which a belligerent is able to control the commercial activities of the enemy with neutral merchants is sea-power; but this in its turn is controlled by practical considerations of geography. In order that you may appreciate exactly the claim of the neutral merchant as put forward by the United States, I have asked a Cubist friend to prepare this map of part of the world by help of which I hope to make things plain (see page 470).

The direct route from neutral **A** to belligerent **G** may be barred by a close blockade: to use the term to which we are accustomed, "rightfully." Now, if goods, any goods, contraband or not, are sent from neutral **A** to neutral **B** and thence to belligerent **G**, it is clear that, equally rightfully, they and the vessel carrying them will in due course be seized for breach of blockade. Therefore the contention that "innocent shipments" may be "freely transported" to and from the United States through neutral countries to belligerent territory" is not accurate. If there is anything at all in the contention it must be limited to those neutral countries, such as **H**, which are contiguous to **G**, the belligerent. At once, therefore, the proposition is "sicklied o'er with the pale cast" of suspicion.

Now, under a close blockade, it is a fact that access from neutral **A** to neutral **H** was not barred. But it is also a fact that **E**, the

belligerent, had a remedy when contraband was found going from **A** to **G** by way of the neutral **H**. The Prize Courts discovered, or evolved, the doctrine of "continuous voyage."

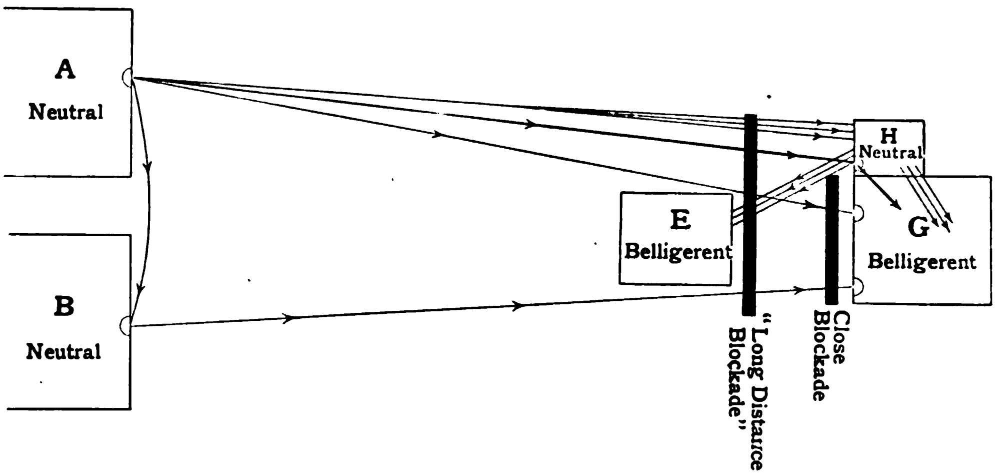

Diagram illustrating the Application of the Doctrine of "Continuous Voyage" to Blockade.

So much depends on an accurate appreciation of the meaning and of the genesis of this doctrine, the whole present dispute between the Allies and the neutrals turns upon it, so many misconceptions have gathered round it, that I shall deal with it at once.

Among the early cases in which the doctrine was established, one of the most instructive is the "William," decided by Sir William Grant in 1806. During the Napoleonic wars the British Admiralty had declared, by "Instructions to the Fleet,"* that neutral vessels should not trade between the enemy countries and their colonies. It is quite immaterial to my argument to inquire whether these "Instructions" were justifiable; they were an exercise of belligerent power, and neutral merchants recognised that if their ships engaged in this trade they ran the risk of being captured. But the ingenious owners of the "William" desired to get a cargo of cocoa from La Guira, a Spanish colony, to Bilbao; and this is how they thought to accomplish it. She first put in at the neutral port of Marblehead in Massachusetts, where the cocoa was unloaded, the ship's bottom cleaned, sugar from the Havannas taken on board, and then the cocoa reshipped, after which she set sail gaily for Bilbao and, falling in with a British frigate, got herself captured. In due course, coming before Sir William Grant, she protested that she was on a voyage from Marblehead to Bilbao, and ought not to have been captured within the meaning of the "Instructions." But that very astute judge pointed out the fallacy of the contention. "The truth," he said, "may not always be discernible; but when it is discovered it is according to the truth, and not according to the fiction, that we are to give the transaction its character and denomination." The voyage from Marblehead to Bilbao was the fiction; the voyage from La Guira to Bilbao was the truth. It was certainly a circuitous voyage, but it was a continuous voyage, and the ship was condemned.

Many such conflicts between the neutral merchant and the belligerent arose during the American Civil War. The same spirit of evasion prompted British merchants to send contraband of war to Charleston stopping at Bermuda and Nassau in the Bahamas. In one well-known case such cargo was sent on board the "Bermuda," and all sorts of ingenious documents were prepared to darken and disguise her true destination. Chief Justice Chase, of the United States, declared that the voyage of the contraband from Liverpool to Charleston did not lose its continuity because of a transhipment, or of a dozen transhipments, at neutral ports. The fact that Charleston was blockaded was immaterial. There was an enemy destination of the cargo which made the contraband seizable at any point of her voyage. And so the doctrine of "continuous voyage" came, from force of circumstances, to be applied to the cargo. The exercise of belligerent power was the declaration that contraband shall not get to the enemy,

* More precisely, "Instructions for the Commanders of our Ships of War and Privateers that have or may have Letters of Marque against France, Spain, or the United Provinces," dated March 28th, 1798.

the "will to profit" prompted the evasion—logic did the rest.

The lesson of this important decision has been wrongly learnt. It has been remorselessly criticised. More than one writer has inveighed against the infringement of precious neutral rights. All unite in declaring that the American Prize Courts created a new doctrine which stretched International Law beyond due limits; though some, I am bound to say, praise their courage and wish our courts, or at least our Government, would do likewise. I think the view I have put before you is the sounder—that there was neither stretching of old nor creation of new doctrine, nor any special courage, involved in the decision. It was simply a question of evolution: the neutral merchant wriggling to cut the meshes of the net which had caught him, the deft fisherman casting the net with logical precision still wider.

So greatly do I believe in this unerring law of evolution that I think I should here state the faith that is in me, even though it startle you. Certain technicalities alone made the Order in Council of March 11th, 1915, necessary. The main principle it laid down, together with the exceptions which I shall presently indicate—the cordon of cruisers being placed in their present stations, and due notification given to the neutrals—would infallibly have been reached by the Prize Court without the Order.

It is often said, and the Declaration of London perpetuated the sayings—first, that this doctrine of "continuous voyage" only applies to absolute contraband; secondly, that it does not apply to blockade. These are the vain imaginings of the theorists in peace time. The Order in Council has applied it even to non-contraband, and Article 19 of the Declaration of London happily received decent though tardy burial on March 30th last.

The "Bermuda" was condemned, and rightly, for carrying contraband to the enemy. But she was also condemned for an attempt to break blockade, for this reason. The American Prize Law, like the English, condemned vessels for the intent and not merely for the fact of breaking blockade. A vessel sailing from Liverpool with intent was seizable one day out. Obviously, in these circumstances, the principle of the "William" applied, and the fact that she put into neutral ports did not cure the intention. So the doctrine of "continuous voyage" in its simplicity was held, and rightly, applicable to blockade, as the American and English Prize Courts understood it.

So, if you will look at my map once more, you will see that according to American and British views as to the rightful exercise of belligerent power, a vessel starting from **A** with intent to break the blockade of **G** could have been seized between **A** and **B**, and her sham neutral destination would not have availed her. The importance of this is not lessened by the fact that we have adhered to the principle of the Declaration of London, that a vessel is now seizable only when she is caught within the area in which the blockading forces are operating.

This inquiry lets a little light on the claim of the United States as to "innocent cargoes," and justifies suspicion of the proposition. It is not to supply them to the enemy merely with the assistance of other neutrals, but with the assistance of those neutrals only who are contiguous to the enemy, and therefore are in a better position to assist in the evasion of the exercise of belligerent power. There is a little rift in the lute; the note of protest is not quite so pure and undefiled as we were led to suppose. There is a quaver in the rendering of that good old song about the freedom of neutral trade. Can we not see the "will to profit" busily at work? Have not the wits of the neutral merchant been sharpened by the geographical fact that there is only a land frontier between **H** and **G**, which prevents the Tyrant of the Seas exercising her sea-power?

Now, looking at the question merely as the play of elemental forces, this is the most natural development in the world. Putting all questions of "right" on one side, it is a very natural attempt at evasion, which the belligerent will naturally and legitimately endeavour to counter. But I protest against the evasion being padded out with old formulas which have nothing whatever to do with the question. The consequences of the geographical fact are plain on both sides; and I maintain that the consequence for the belligerent is that as his sea-power cannot be exercised to stop supplies going from **H** into **G** in the same way as it can stop them going from **B** into **G**, it *must* be exercised before they get to **H**; cargoes going to **H** with an enemy destination *must* be intercepted.

At this point a little analysis will be profitable; and I put this question, What foundation is there for the assertion that trade between the neutral merchant and the enemy in any form is a "right"? Trade is bilateral; it is made up of a vast series of contracts; and what is true of one is true of the mass.

I must, however, here interpose the remark

that if all contracts which related to supplies of any kind to the enemy were made f.o.b., much of the trouble would be removed. The property in the cargoes having passed out of the vendor we should have nothing to deal with but enemy property. I have quite enough on my hands without raising the ghost of the Declaration of Paris; but I may say that, by the light of what we know now as to the inner meaning of non-contraband, the notion that the neutral flag covers enemy goods except contraband is contrary to the spirit of neutrality. The legitimate counter-stroke is the exercise of the right involved in blockade; for that right annihilates the doctrine of the Declaration that "free ships make free goods."

But with regard to trade which is carried on by the neutral merchant who does not avail himself of the contract f.o.b., if it is true to say that he has a "right" to have his contract left intact by the belligerent, so also must the other party to the contract, the enemy, have that right. But this is negatived by contraband and blockade. The "right" of the neutral merchant must, therefore, be a very one-legged business, and the only way in which the body of it can be kept standing would be by substituting the belligerent in the contract for the enemy—pre-emption in fact. But President Wilson likes pre-emption no more than he does condemnation. Let us, however, be serious. Is a person to be heard to say to a State, "You cannot put that man in prison or condemn him to death, because he is under contract with me to perform certain duties"? If he cannot say this to a State in peace, how can he say it to a State at war? Yet that is what the neutral contractor in effect says to the belligerent.

Oh, but, it is said, seizures in the case of contraband and blockade are the result of a "compromise." The materials for a compromise in such a matter between neutral merchant and belligerent are not very promising. Even a compromise between the belligerent and neutral Governments will not hold water, for a neutral Government does not protect its merchants when they carry contraband or break blockade. It simply abandons them to their fate: withdraws, as it is called, the protection of its flag. And their fate is decided for them by the belligerent.

But I put this further question: Why is interference with the belligerent right of war to be tolerated? War hath her rights not less inviolable than peace. Do not such epithets as "lawful" and "innocent," when applied to trade which does in fact interfere with the conduct of war, beg some question which has as yet never been fully stated? "Lawful" undoubtedly does; and as for "innocent" it means not harmful. Is not this term disposed of by the consideration that the right of judging whether harm will result from neutral trade must rest with the belligerent—cannot be with the neutral merchant? And this consideration is admitted on all sides to be sound, because the list of contraband and the declaration and extent of blockade are within the discretionary right of every belligerent.

Have I not said enough to show that what the United States really claims is this: that, although the belligerent can stop all cargoes going direct from the neutral merchant to the enemy, yet he may not stop them when they are going indirectly? Such a claim is based on evasion of belligerent power, and evasion cannot be raised to the dignity of a "right."

The only accurate appreciation of the facts is, that seizure of all cargoes going direct or indirectly to the enemy is the exercise of the primeval right to treat any one who assists my enemy as being himself my enemy.

But I will not plead guilty to the charge of heterodoxy; I have protested against the misuse of the term "right," not so much against its use. "Law" has been in such constant use since the subject came first to be discussed that it is not lightly to be abandoned. What is law? It is the determination where right lies in the ever-varying circumstances of human life. The primary right not to be interfered with in the doing of anything which is not unlawful often entirely disappears under the influence of the general maxim *sic utere tuo ut alienum non lædas*. It is only in this restricted sense that you have a right to use the King's highway; but, if you do not violate the statute of the land, you may even use it unlawfully, or rather negligently, as by tying up a donkey in the middle of the road, or by riding furiously along it, so long as there is no one in the way. But the secondary or positive rights spring from the circumstances of daily life, and vary with them; and if the circumstances some fine morning should evolve this curious coincidence, the negligent tying of the donkey in the road and the furious rider along it, resulting in a collision in which both donkey and horse are killed, it is conceivable that the owner of each should bring an action against the other; the judges would then have to disentangle the threads of circumstance in order to determine the resultant rights.

Now in the matter of negligence and contributory negligence the Courts have hit out these rules for dealing with them:—first, the defendant being negligent, he is liable for the damage suffered by the plaintiff; but, secondly, the plaintiff's duty is to avoid the defendant's negligence if he can, or he will be held to have been contributorily negligent; but, thirdly, the defendant's duty in his turn is to avoid the plaintiff's contributory negligence if he can, or he will not save himself from the consequences of his original negligence.

I see in these common law pedestrian cases (*Davies* v. *Mann* and *Butterfield* v. *Forrester*) a clue to the problem of the rights and duties of nations in this conflict between commerce and war. We have always maintained that the springs of right which should govern the conduct of nations are the same as those which govern the conduct of the individuals which compose them. One branch of the British argument in the Behring Sea dispute, where the question was what rights of property a nation could claim over the seals when they left their breeding-grounds on the Pribyloff Islands for the Pacific Ocean, was entirely based on the analogy of the law as to the coneys, and of the rights of an owner of decoy ponds as declared in the suit of *Keeble* against *Hickeringill*. The principles governing the duties of man in the infinite variation of human action must also govern the duties of nations in the infinite variation of national action. This is what I take International Law to be; and I presume that these are the principles on which the Hague Tribunal will act, the circumstances arising. There is no international law of contract or of tort, nor any international criminal law, which differs in its principles from municipal law. The invasion of Belgium by Germany, reduced to its essence, was trespass on a national scale, far removed in degree, but the same in quality as the trespass, long years ago, of the villagers who followed Oldacre, huntsman of the Berkeley, over the property of Mr. Hume.

The reason, then, why I seek in the subject in hand an analogy from the common law of contributory negligence, is that the law, with its acute perception of the springs of human action, finds in them an alternate, almost rhythmic beat of cause and effect—effect transmuted into cause, and so on in endless series; and in the rules of evidence, the machinery for ascertaining the right, the burden of proof is perpetually shifting from one side to the other. This alternating beat is palpable in the law of contraband. Reduced to its essence, it is the result of the perpetual conflict between commerce and war, the alternating rhythm in the play of those larger natural forces which engender wars and the desire to profit from them. You will find clearly traced the interference of the trader in the conduct of war countered by the belligerent; the counter evaded by the trader; the belligerent countering him once more, and so on; evasion, prompted by the "will to profit," and counter-stroke, prompted by the "will to win," in regular recurring series, as I will endeavour now to show you.

I assume fighting and trading to be elemental forces, and I premise only these two primary rights to evolve from them: that of a belligerent nation not to be interfered with in its war; that of a neutral merchant not to be interfered with in his legitimate trade.

I assume, further, that if a belligerent were to interfere deliberately with the normal trade of one neutral merchant with another it would give rise to a just ground of complaint.

The belligerent power to which I refer may, of course, be exercised by both belligerents; and the trade of the neutral merchant may also be with both belligerents. But, for convenience, I deal only with the case of one belligerent to whom the balance of sea-power has left the command of the sea; and him I refer to as "the belligerent"; his adversary who has lost command of the sea I refer to as "the enemy." The "neutral" is the neutral merchant of any State, but not the State itself.

It is not difficult to see how these two elemental forces came early into conflict. Alberic Gentilis tells us* that in the time of the Armada the traders helped the Spaniards both with provisions and munitions of war, and that the English "requested" them to desist. The traders replied that the request was against the law of nations and a violation of the freedom of trade. Whereon Gentilis remarks—"An all-important question this. Equity was with the English; strict law was with the traders. The latter wished to avoid the loss of the profits of their commerce; the former objected to the doing that which imperilled their safety. The rights of traders are to be respected, but still more the safety of the State." I do not know where Gentilis got his "strict law" from; but he certainly appreciated the natural principle which all the world from all time has recognised—the right of self-defence; and he puts the

* I have availed myself here of Dr. Walker's valuable "History of the Law of Nations."

justification for the attitude of the English expressly on this ground, calling it "equity."

From this point development must have been along two inevitable channels. The merchant would appeal to his Government to help him recover his goods; the belligerent would also appeal to that Government to keep its traders within its own neutrality. The Government would point out to its merchants that action on its part would imply justification of their trading, and be inconsistent with its neutrality towards the belligerent; and to the belligerent it would answer, "If we stopped our merchants trading we should be helping you, and that would be inconsistent with our neutrality towards your enemy." So the trader, neither forbidden nor protected, followed the lure of the dollar and ran the risk; and, seeing that the belligerent could not deal with him in the neutral country, the risk he ran was at sea, when the belligerent's cruisers were about. His cargoes were seized.

But what of the "freedom of the sea" and the jurisdiction of the national flag? The jurisdiction of the flag depends for its specific exercise on express municipal enactment, and in this case there is none; the protection on which the freedom of the sea depends is withdrawn.

These principles are condensed into the formula: a neutral merchant sends contraband to the enemy at his own risk at sea; or, if it has been sold f.o.b., at the risk of the consignee.

At this point a positive right has developed out of the circumstances of war, known as "the right of search"; and a correlative duty to submit to search under penalty of being fired into and compelled to heave to. The recognition of the power to seize has engendered this logical train of reasoning. In order to capture contraband on its way to the enemy you must first ascertain by examination whether there is anything to capture. This right is an outcome of, this duty is a recognition of and submission to, the right of war; and from its nature all neutral vessels submit to it anywhere on the high sea; though discretion and practical considerations have limited its exercise to vessels with enemy destination.

All this sounds very arbitrary when it is stated in so many words. But when words are translated into practice we know that there is an Intelligence Department with infinite ramifications whose researches turn suspicion in a multitude of cases into certainty. With a curious inversion of logic one of the by-arguments of the American Protest seems to insist that you ought not to suspect until you are certain.

Note here that this submission to the right of search has led to the evolution of the duty to search, the omission of which lies at the root of the German "frightfulness" at sea. Note, too, one natural development of power. Search would, in ordinary circumstances, be conducted at sea. But the growth in the size of ocean steamers and the complexity of their cargoes have made it necessary to bring ships into port for examination; and it has been skilfully pointed out in the recent British reply to the United States that this is in reality yet another example of the manner in which belligerent power must and will counter the evasions of the neutral merchant. Search for contraband at sea has become increasingly more difficult, evasion increasingly more easy. Copper can be concealed in bales of cotton, rubber in trusses of hay. *Therefore* the search must be more thorough; *therefore* it must be conducted in port.

Another development is to be noted in regard to the list of contraband itself. The power of declaring what goods shall not go to the enemy rests with the belligerent. Why? For the simple reason that, being at war, he *will* do so. To say that the artificial ideas which have engendered conditional contraband and the "free list" are to bind the belligerent for evermore is to say that war is to stand still while the world goes round. War is no longer conducted by standing armies. Nations are now in arms. But, say the purists, "munitions of war" is a fixed definition, and must never be enlarged. According to them "foodstuffs" are only conditional contraband; and raw cotton, oil seeds and nuts, and rubber, and metallic ores are on the "free list." Perhaps it is better to drop the curtain at this point over the vain endeavours of the Declaration of London to achieve the impossible.

But the important developments, wherein the alternating shock and counter-shock of the elemental forces are so clearly visible, are to be found in the emergence and gradual amplification of the doctrine of "continuous voyage."

The belligerent declares that he will seize contraband going to the enemy. "Very well," says the neutral merchant, "I will send them to a neutral country first. 'Neutral trade is free,' and a neutral country wants all sorts of things, including munitions of war for its own protection. Therefore, if my vessel is bound for a neutral port, the idea of enemy destination must be negatived." Most ingenious; and still

more ingenious if a neutral port is selected at a nicely convenient distance from the enemy ports, so that the risk of seizure is reduced to the short run in; because contraband destined for the enemy is seizable anywhere on the high sea, and the risk would then be eliminated all the way from Liverpool to, say, Nassau.

Not thus are Prize Court judges easily deceived. *Prudens simplicitas!* To imagine that because a ship bound for Charleston puts in at Nassau she is not bound for Charleston! A devious voyage truly, but nevertheless a continuous one. Thus the simple evasion was countered, and the Prize Court wins the stroke.

Whereupon the neutral merchant says to his agent in the neutral port, "let us tranship the cargo into another vessel, and then send it on to our friend the enemy." The evasion was too palpable, and the long arm of the Prize Court condemned these "innocent cargoes." True it was that the enemy destination of the cargo had previously been inferred from the enemy destination of the vessel which carried it; but though you tranship it into another vessel, the enemy destination of the cargo is not changed. Nor is it changed if you were to tranship it a dozen times at a dozen neutral ports, of which one might be St. George in Bermuda and another Nassau in the Bahamas. Thus was this new evasion countered, and the Prize Court wins the second stroke.

Undefeated, the merchant was prompt with a fresh evasion. There shall be something more than a mere transhipment; the goods shall pass into the Customs, pay duties, do everything needful to hoodwink the watchful frigates. But the logic of the Prize Court was inexorable. "Not so, my friend; lightly come may lightly go. The payment of the extra shipping charges does not deceive us; the enemy wants these goods, and what do a few thousands of pounds more or less matter in war? If, as you say, these cargoes are really for the neutral, when they would be 'neutral trade' and free, they must be going into the 'common stock' of the neutral port; thus alone can we be sure that they are not going to the enemy." So was the third evasion countered, and the enunciation of the "common stock" principle gave the Prize Court yet another point in the game.

Let us note, by the way, that all this time the neutral merchant's Government has been sitting with hands folded, merely watching the game, and seeing fair play.

But now comes the turn of the neutral merchant to score. If "not unmoved, yet undismayed," he sets his wits to work once more, and finds the way of evasion open before him. You follow the conditions: the vendor in the neutral country, the enemy purchaser, the confederate in the intermediate neutral port. Between them they arrange that the cargoes shall pass into the common stock of the neutral port, and that presently, when vigilance is relaxed and suspicions are allayed, they shall come out of it again. Nothing could be much simpler for three sharp-witted men. The necessary secret arrangements between neutral vendor and enemy purchaser with the neutral merchant at the intermediate neutral port are not very difficult to imagine or to carry out. The purchaser is the enemy; it is a gratuitous assumption that the vendor is neutral; it is equally gratuitous to assume that the intermediary agent is neutral, or even innocent; he also may be an enemy ensconced in the neutral port to carry on the business of the Fatherland.

But before giving my reasons for believing that the Prize Court must win the last stroke in the game, I must pause to deal with the question of blockade. From its nature there has been no scope for the play of the elemental forces. It was just a simple struggle between belligerent and neutral merchant: pull devil, pull baker. The belligerent declared his intention of seizing all vessels and all cargoes going to the blockaded coast; the merchant declared his intention of getting his cargoes through the blockade if he could. All clumsy disguises were thrown to the winds, no subterfuges were necessary; the merchant (I beg you to note that he still persists in calling himself a "neutral" merchant) is going to run the blockade, and take the risk of seizure.

Developments have, however, arisen owing to the increase of weapons of defence employed by the enemy to destroy the effect of the blockade on himself, and so enable the merchant to reach his ports unmolested. The "imminent danger" to vessels trying to get in—the characteristic feature of blockade—may be entirely eliminated by the creation of an offensive force of submarines, aircraft, mines, and swift cruisers, operating against the blockading squadron. The inevitable result has been to push the squadron farther and farther out to sea.

Now, the United States Government admit the imperious force of circumstances; they agree that the blockading squadron need no longer stay in the offing; but they put it no higher than this, that the ships may be moved out of

harm's way, for they see that if it were to be justified on broader grounds the consequences to their contention would be so formidable that it would crumble away. For when the squadron moves seaward from the offing access to neutral ports will be barred, and so apparently the whole gospel of blockade will be scattered to the four winds of heaven.

But the United States Government propose the simplest of methods for picking up the pieces—free entrance and exit through the blockading squadron must be allowed to neutral traffic. Hence the famous postulate about "lawful traffic" and "innocent cargoes."

But let me remind you that we already know a good deal about this formula, and find it no true postulate at all, but only a thin screen of words devised to hide the truth that the neutral merchant intends to use the land frontier between neutral **H** and belligerent **G** for all it is worth. And we are agreed that evasion of belligerent power cannot involve the elimination of that power from its legitimate field of action. The inevitable conclusion I suggested as the result of the neutral merchant's action was that all cargoes going from **A** to **H** with an enemy destination *must* be stopped. And here, following the law of development along another channel, the method of stopping them has been found.

We are dealing with elemental forces, and I confess that I do not value at two pence considerations such as this: can this be called a "blockade" in the strict sense of the term? or this, that those old hampering conditions attached to blockade preclude us from using this new manifestation of power to its utmost; or this, that the geographical configuration of the group of neutrals which cluster round the enemy makes it impossible to enforce the blockade with equal rigour against all neutrals, for the old rule only forbad deliberate partiality between them. The base right is this, that from time immemorial cutting off *all* supplies from the enemy has been recognised as a belligerent right. The neutral merchant and the enemy between them, with the assistance of a well-paid third party, have devised means for evading the exercise of this power; they persist in getting goods across the land frontiers, or through the territorial waters, of contiguous neutral countries; therefore they must be stopped, and the "long-distance blockade" is the obvious method of stopping them. Any attempt to control this exercise of power by reference to old formulas, or to antique definitions which cling like barnacles to the word "blockade," is merely a confusion of means with the end. And specially in regard to that old definition that "blockade may not bar access to neutral ports," the simple answer is that the close blockade never intended to.

And this brings our old friend the neutral merchant once more upon the scene. He had to submit to blockade because he could not help himself. But this new development touches him even more acutely, and he protests. Now part of his protest is perfectly sound: trade between neutral and neutral must not be interfered with; nor is it. Free exit and entrance must be granted, and is granted, to ships in that trade, because "neutral trade is free." But we have already got the measure of the subtlety of the neutral merchant's mind. We know what he means by "neutral trade," and how the doctrine of "continuous voyage," with its attendant principle of "common stock," gradually emerged to check his version of it, which was that it covered his trade in contraband with the enemy through neutral countries. It is the same old story once again: the same attempt to treat the merchant's interest in his contract with the enemy as distinct from the enemy's interest; to maintain that though the belligerent may stop the enemy receiving commodities from the neutral, yet he must allow the neutral to send them to the enemy. The American view of the "long-distance blockade" is that it is merely a development of defence against the growing power of the enemy which must not affect the neutral merchant. The sounder view is that it is a development of offensive power necessitated by the new circumstances in which neutral trade with the enemy is carried on—the increased importance of contiguous neutral countries in regard to conveying supplies to the enemy; the increased danger to the belligerent of a meaningless doctrine which got itself into, and has now been got out of, the Declaration of London, that the doctrine of "continuous voyage" does not apply to blockade. Such a development must affect the neutral merchant's indirect trade with the enemy, because it is in fact a deliberate check to the enemy receiving supplies indirectly from the neutral merchant. The doctrine of "continuous voyage" is an integral part of the new blockade; it is its meaning and intent; it would have been sheer madness had it not been made part of the Order in Council.

The doctrine of "continuous voyage" must apply to the stopping of *all* supplies as it does to the stopping of *some*, because, in plain language,

it is a check to devious trading. The sum and substance of the American claim is that the American merchants may trade with the enemy deviously although we have declared that the enemy shall not receive *any* supplies. You see how that idea that the doctrine of "continuous voyage" does not apply to blockade hampers us; you see now, I think, clearly why a regular blockade has not been declared, and why Article 19 of the Declaration of London has now been discarded.

The point I have endeavoured to make good so far is that blockade and contraband are in their essence only different manifestations, varying in degree, of belligerent power, and that whatever rules apply to the one cannot be arbitrarily excluded from the other. The test whether goods destined for a neutral country shall be allowed to pass through the "long-distance blockade" must, therefore, be whether they are destined to go into the "common stock" of the neutral country.

I now take up the thread of the question of contraband.

I have on two occasions quite recently explained how what the text-book writers are pleased to call "the law" stood at the outbreak of war. But it is of such infinite importance that the difficulties which faced the Government, and still face them, should be understood, that I venture for a third time to refer to it. It was not so much that in preparing the Declaration of London the theorists played havoc with the rights of war; it was their occult interpretation of the terms used which cramped belligerent action.

Article 30 of the Declaration of London declared that absolute contraband is liable to capture if it is shown to be destined to the enemy, whether the voyage be direct or indirect. But the commentators, with whom the protection of the rights of neutral merchants had become an obsession, who ignored altogether the existence of belligerent rights, had spun a web of theories round the term "enemy destination" which, in spite of the respect in which we hold some of their names, can only be described as fantastic. Here is what Westlake writes in the second edition of his book on "War," published in 1913: "When goods on a ship destined to a neutral port are consigned to purchasers there, or to agents who are to offer them for sale there, they have only a neutral destination; they have gone into the common stock of the country. If they ultimately find their way to a belligerent port, or to a belligerent army or navy, it will be in consequence of a new destination given them, and this notwithstanding that the neutral port may be a well-known market for the belligerent in question to seek supplies in, and that the goods may notoriously have been attracted to it by the existence of such a market. The consignors of the goods to the neutral port may have had an expectation that they would reach the belligerent, but not an intention to that effect, for a person can form an intention only about his own acts, and a belligerent destination was to be impressed on the goods, if at all, by other persons. Therefore it is not contended by anyone that on the way to the neutral port there will be a right of capture, *whatever the character of the goods.*" I beg you to note that all this applies to contraband of war!

It is impossible to imagine that any such fine-drawn rule will bind a nation at war; it is preposterous to suppose that a nation at war, when its existence is at stake, will sit quietly by and see these things going to the enemy, and console himself with the reflection: "Ah, well! he is entitled to them." On the face of it such a rule could never be accepted. *Placuitne gentibus?* Have the nations agreed to this indirect supplying of the enemy with munitions of war? Surely, No. The life-law of States, the right of self-defence, negatives the possibility of such a rule coming within the range of International Law—would justify its disregard even were the possibility admitted. Some things are lawful for belligerents to do, and some things are not lawful; yet there is an imperious necessity which impels nations, and men too, to do them and stand the racket.* If there is no other way out of the difficulty, the thing will be done and the consequences taken so long as the imminent danger be averted. The history of every country abounds in them. There is the case of Amelia Island and the adventures of the bold buccaneer McGregor in 1817, when Buenos Ayres and Venezuela were insurgent colonies of Spain; there is the case of the "Caroline," which in 1838 was seized by the Canadian authorities in a United States port, set on fire, and sent over the Falls of Niagara; there is the punishment of the Pensacola Indians in 1815, and the destruction of the forts on the Appalachicola River; and the case of Greytown, and of the British Orders in Council of 1807; and

* The right of self-defence, which Gentilis recognises as the foundation of all interference with neutral trade with the enemy, but which modern commentators persistently ignore, holds so paramount a position in the subject that I have ventured to incorporate at this point a passage from my letters to the *Times* in 1893, which summarised Sir Charles Russell's argument in the Behring Sea Arbitration.

there is the case of Mason and Slidell on board the "Trent." All these were as wrong as wrong could be, judged by any rule of International Law, and yet fulfilled the test of legitimate self-defence which Mr. Webster laid down in the case of the "Caroline"—that the necessity must be "instant, overwhelming, leaving no choice of means and no moment for deliberation." These are the things that a nation will do when it is forced by circumstances and yet remain on the side of the angels, nor lose one particle of its national honour. I maintain that if there were such a rule as is claimed by the authors, then the Government of a State would be mad if it sat quietly by and acquiesced in the enemy getting the supplies it urgently needs from neutral merchants, whether they be contraband of war or not.

But I need not take such high ground in defence of the Order in Council. I maintain that this imaginary rule is bad because it is impotent to bind, because it invites disobedience at the first stressful moment of war, and that it will not stand the most elementary test even as a principle of guidance. I maintain that it is illogical, that it divorces plain words from their most plain meaning. "Enemy destination" means that the goods are going somehow to get to the enemy.

The Order in Council swept these theories into the limbo of forgotten things, and from March 11th, 1915, the British Government with the Allies asserted the wider, bolder, truer doctrine—truer, because there are a dozen ways in which the good intent of the "common stock" principle could be evaded, and under cover of it goods be sent deliberately to the enemy. "Enemy destination" means exactly what it says, and says exactly what it means; and what it means is this—that if there is an intention, or a hope or certain expectation, I care not in which of the many parties who may be interested in a cargo, that the goods shall get to the enemy, then "enemy destination" is impressed on them. If the enemy himself, or anyone acting on his behalf, has any part or share or interest in the contract, then the destination needs no further proof.

Bear with me a few moments longer while I remind you how the game stood when we last saw the neutral merchant facing his opponent, the Prize Court. He was losing heavily; every stroke had gone against him. Evasion after evasion had been countered, not by arbitrary decision, but by a remorseless logic which followed him step by step. Yet it seemed as if he had a chance of winning the last stroke, the chance being that logic should cease to work and the Prize Court fall a-napping. The odds, too, you will remember, were in his favour: the learned authors and the theorists had backed him to win, and that unhappy Article 19 of the Declaration of London was equal to a stroke in hand. But now we have come to analyse his play, what have we found? Nothing but the same old trick; always the endeavour to get in below his opponent's guard. And as the Prize Court has defeated him in the past so I believe it would have defeated him in the present. As I have already said, my faith in the law of evolution is such that, even if there had been no Order in Council, I am certain that the Prize Court would have arrived inevitably at the conclusion that the doctrine of "continuous voyage" is and must be applicable to the "long-distance blockade," and that it would be able to say, as Sir William Grant said in the case of the "William" in 1806: "On the whole, I trust, I have demonstrated . . . that we do not in the case before us depart from any principle which we have ever adopted."

So much for the case which is made against us by the Government of the United States on behalf of its traders who use its name and its flag in vain. There still remain two classes of critics among our own people—those who say we are trampling on neutral rights, and those who contend that our policy is not vigorous enough.

To those who say, "Are, then, neutral merchants at the mercy of belligerents?" I answer, No. That old formula, "neutral trade is free," is still a live principle even of the most belligerent action. And it follows from every word I have said that the test of "rightness" by which that action is to be judged, and will be judged by history, is the respect which the belligerent pays to it. Between the neutrals A and H there is a vast amount of normal trade which does not touch even the fringe of war, because it does not in any way, however indirect, aid the enemy. That trade must be left inviolate, and is so left.

And now for those who cry aloud for a still more vigorous policy, and declare that many things are getting through the blockade to Germany. It would be most injudicious, to say the least — it would be a flagrant disregard of the rules of this ancient and Royal Society, to say the highest—were I to plunge into the controversy of figures which the unofficial asserts, and which the official

denies, show that there is an amount of goods getting through to Germany in spite of the blockade because of its weak enforcement. But there is so much genuine misunderstanding of the whole subject that I think I may, consistently with the rules of propriety, point out the theoretical aspect of this thorny question.

Between the two extremes—on the one side, purely genuine neutral trade; and, on the other, the trade which by many devious devices is in fact benefitting the enemy, but to which the doctrine of "continuous voyage" may legitimately be applied—there are a multitude of doubtful cases in which both elements are more or less present. I have tried to indicate them on my map by these two sets of lines which show what the "common stock" principle really means, and how at a given point the doctrine of "continuous voyage" must fail to help us. All those lines from **A** which stop at the coast-line of **H** represent genuine neutral trade which must not be interfered with; and all those lines between **H** and **G** represent lawful trade, even though it be in contraband of war. And, further, there is the mass of normal and abnormal trade shown by the lines between **H** and **E** which it is essential to ourselves to preserve. These are the ingredients of the problem with which the Government of the belligerent **E** is faced. It must, if it can, destroy the trade between **H** and **G**; it could do it unlawfully by cutting off all the trade between **A** and **H**; but—and this is the point which is so often forgotten—trade is in the hands of the neutral merchants, and not of the neutral Government; it is essential to preserve friendly relations with those merchants. They are not bound to continue either the trade between **H** and **E** or between **H** and **G**. It is a question of bargaining, of offering advantageous terms; it is a question for arrangement, for agreement, for "rationing," if they will acquiesce in it. There is a point at which the exercise of power fails the belligerent; the only way to achieve his purpose is by fair means. He must no longer be the strong man armed; he must agree quickly, and while there is yet time, with the neutral merchant within his gates.

DISCUSSION.

Mr. Arthur Hudson, K.C. (late Attorney-General of the Gold Coast), in opening the discussion, said the author had given an excellent exposition of the subject with which he entirely agreed. No one, whether layman or lawyer, who had listened to a story told with such graceful wit and lightened by such delightful imagination, could fail to derive great pleasure and benefit from it.

Mr. John Leyland thought the author had shown in the clearest possible light the conditions which existed between belligerents and neutral powers. Much was heard in every war of the rights of neutrals, but very little of the rights of belligerents, and Sir Francis had most clearly dealt with that point of view. Like the last speaker, he agreed entirely with everything the author had said.

The Chairman (Dr. Dugald Clerk, F.R.S.), in proposing a hearty vote of thanks to the author for his most instructive paper, said he had listened to many interesting papers of a similar type, but he had never heard a more clear and logical account of a very thorny subject than that delivered by Sir Francis. The clever attempted evasions of neutrals were clearly dealt with, and it was possible to see at once how wrong the American contention was. The American objection to the belligerents stopping trade with neutrals, and the assertion that belligerents had no right to assume that goods were on board a ship without actually knowing it beforehand, appeared, at first sight, very plausible, but on analysis they were proved to be absurd. The author had clearly shown how justifiable the Order in Council was in dealing with such trade in the manner it did.

The resolution of thanks was carried unanimously, and Sir Francis Piggott having briefly acknowledged the compliment, the meeting terminated.

GENERAL NOTE.

Tobacco Fertiliser from Indigo Plant.—The residue of the indigo plant, after the extraction of the indican, known commercially as indigo, is used in the Karachi district, and probably also in other parts of India, as a fertiliser for the tobacco plant, says the United States Consul at Karachi in a recent report. This substance is known locally as "seeth." The roots of the tobacco plant require free access to air, and seeth breaks up the ground in a way which allows the air to penetrate. Experiments have been made recently by the Agricultural Research Institute at Pusa with the object of securing better results from the use of seeth. The substance has been used for years by the natives, but little scientific work has been done in India until the last ten years. The experiments so far indicate that tobacco soil in which seeth and bits of broken tile or broken chatties (baked clay water-jars) are mixed produces better crops than soil under no special treatment. The cost is moderate, and the results achieved warrant the

extra expense. A plot of tobacco land near Pusa was treated in this way nine years ago, and has shown marked superiority over adjoining plots ever since. Indigo, adds the Consul, has had a remarkable "boom" since the war began, and the amount of seeth available as fertiliser has increased accordingly.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

May 17.—George Percival Baker, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe." Sir William Martin Conway, M.A., F.S.A., F.R.G.S., will preside.

May 24.—John Collett Moulden, A.R.S.M., M.Inst.M.M., "Zinc, its Production and Industrial Applications." (Peter Le Neve Foster Prize Essay.) Dugald Clerk, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

Indian Section.

Thursday afternoon, at 4.30 p.m.:—

June 1.—Professor Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India." The Right Hon. Lord Islington, G.C.M.G., will preside.

June 23 (Friday).—Sardar Daljit Singh, C.S.I., "The Sikhs."

Cantor Lectures.

Monday afternoons, at 4.30 p.m.:—

J. Erskine-Murray, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves, and Resonance." Four Lectures.

Syllabus.

Lecture III.—May 15.—*Waves in the Ether.* Free and conducted—Light, heat, and electric waves—Alternating currents—Telephonic transmission—Wireless telegraphy—Submarine cables—Inductance, capacity, and resistance—Limits of known wave-lengths—Röntgen rays—Light—Heat—Reflection, refraction, and diffraction of wave motions—Stationary waves—Attenuation and distortion of travelling waves.

Lecture IV.—May 22.—*Resonance.* Mechanical and electrical—Superposition of periodic impulses—Universal importance of the selective absorption of wave motions—Mechanical resonance or revibration—Screening of vibrations, absorption, and filtration—The acoustics of buildings—Sound resonators—Absorption of light waves—Coloured glass—Vision and photography—Absorption of electrical power by resonance—Tuning in telegraphy.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 15...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Dr. J. Erskine-Murray, "Vibrations, Waves, and Resonance." (Lecture III.)

Tuesday, May 16...Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m. 1. Sir J. Athelstane Baines, "The Recent Trend of Population in England and Wales." 2. Mr. J. W. Nixon, "War and National Vital Statistics, with Special Reference to the Franco-Prussian War."

Institution of Petroleum Technologists, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. A. Campbell, "Petroleum Refining."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "Unconscious Nerves—their Functions in Internal Life." (Lecture I.)

Anglo-Italian Literary Society, 22, Hyde Park-square, W., 5 p.m. Signor Gino Calza-Bedolo, "Con l'esercito italiano alla fronte di Gorizia."

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Mr. C. D. Burns, "World Relations and World Organisation—the Political Aspect."

Wednesday, May 17...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. Mr. G. P. Baker, "Hindu Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries and their Influence on the Tinctorial Arts of Europe."

Meteorological Society, 70, Victoria-street, S.W., 4.30 p.m. Mr. L. C. W. Bonacina, "On the Re-adjustment of Pressure Differences: Two Species of Atmospheric Circulation and their Connection."

Microscopical Society, 20, Hanover-square, W., 8 p.m. 1. Mr. J. W. Purkiss, "Some Suggestions regarding Visual Efficiency in the use of the Microscope and other Optical Instruments." 2. Mr. A. T. Watson, "A Case of Apparent Intelligence exhibited by a Marine tube-building Worm, Terebella conchilega." 3. Rev. H. Friend, "Alien Oligochaets in England: Dichogaster lageniformis sp. n."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor W. L. Courtney, "Dramatists and War."

Thursday, May 18...Chemical Society, Burlington House, W., 8.30 p.m. Lecture by Professor F. Gowland Hopkins.

Royal Institution, Albemarle-street, W., 3 p.m. Sir E. Ray Lankester, "Flint and Flint Implements." (Lecture III.)

Historical Society, 7, South-square, Gray's Inn, W.C., 5 p.m. Mr. B. Williams, "Minorities in War-time. A Study in Political History."

Friday, May 19...Royal Institution, Albemarle-street, W., 5.30 p.m. Colonel E. H. Hills, "The Movements of the Earth's Pole."

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Mr. D. Adamson, "Spur-Gearing."

Saturday, May 20...Royal Institution, Albemarle-street, W., 3 p.m. Professor H. S. Foxwell, "The Finance of the Great War—New Problems and New Solutions." (Lecture I.)

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FRIDAY, MAY 19, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MAY 22nd, 4.30 p.m. (Cantor Lecture.) J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves and Resonance." (Lecture IV.)

WEDNESDAY, MAY 24th, 4.30 p.m. (Ordinary Meeting.) JOHN COLLETT MOULDEN, A.R.S.M., M.Inst.M.M., "Zinc, its Production and Industrial Applications." (Peter Le Neve Foster Prize Essay.) DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

SUMMER TIME ACT.

As this Act will come into force on May 21st, notice is given that after that date the hours of the Society's meetings will be announced in accordance with the provisions of the Act. As it may be necessary to alter the hour of some of the meetings, Fellows are advised to assure themselves by reference to the latest issue of the *Journal* as to the time at which any particular meeting will be held.

The Cantor Lecture on Monday, the 22nd inst., will be delivered at 4.30 p.m. modified time (3.30 p.m. true time).

PROCEEDINGS OF THE SOCIETY.

TWENTIETH ORDINARY MEETING.

Wednesday, May 17th, 1916; SIR WILLIAM MARTIN CONWAY, M.A., F.S.A., F.R.G.S., in the chair.

The following candidates were proposed for election as Fellows of the Society :—

Bates, Mrs. Adah Lilian, 16, Summerland Mansions, Muswell-hill, N.

Bates, Thomas Bradford, 16, Summerland Mansions, Muswell-hill, N.

Bates, Thomas House, 21, Summerland Mansions, Muswell-hill, N.

Gordon, William John, 83, Thurleigh-road, Balham, S.W.

Piggott, Sir Francis Taylor, M.A., LL.M., Little Woolpits, Ewhurst, Guildford, Surrey.

Tyrie, Colonel David A., V.D., A.D.C., 21, Strand-road, Calcutta, India.

Venables, William Henry, 129, Fordwych-road, Cricklewood, N.W.

The following candidates were balloted for and duly elected Fellows of the Society :—

Alcoff, William, c/o J. K. Robinson, Iquique, Chile, South America.

Apcar, John Gregory, 44, Chowringhee-road, Calcutta, India.

Barnes, Professor James Hector, B.Sc., F.I.C., Punjab Agricultural College, Lyallpur, India.

Black, Professor A. Bruce, State Normal School, Bloomsburg, Pennsylvania, U.S.A.

Goculdas, Narottam Morarjee, Shanti Bhavan, Pedder-road, Bombay, India.

Horne, William Edgar, M.P., 5, Tilney-street, Park-lane, W.

Isachsen, Halfdan B., Stavanger, Norway.

Janji, Suryabhan, Camp Keliweli, Akola District, Berar, India.

Mukhopadhyaya, Kumar Sree Panchanan, Uttarpara Raj, Uttapara, Bengal, India.

Newlands, Alexander, M.Inst.C.E., Highland Railway, Inverness, Scotland.

Northcliffe, Lord, 22, St. James's-place, S.W.

Oakden, William Edward, F.C.S., M.S.C.I., 11, Lonsdale-road, Barnes, S.W.

Saklatvala, Nowrojee B., Messrs. Tata, Sons & Co., Navsari Buildings, Fort, Bombay, India.

THE CHAIRMAN, in introducing the author, referred to the beautiful examples of hand-painted calicoes shown in the hall, and to the coloured lithographs, which he understood were specimens of the plates to appear in a work on the subject that Mr. Baker was preparing. It would be seen that the specimens were very frail, and it was not surprising that good specimens were now rare.

The paper read was—

EAST INDIAN HAND-PAINTED CALICOES OF THE SEVENTEENTH AND EIGHTEENTH CENTURIES, AND THEIR INFLUENCE ON THE TINCTORIAL ARTS OF EUROPE.

By George Percival Baker.

The late Professor Meldola, in his presidential address to the Society of Dyers and Colourists in 1910, very rightly laid down the desirability of technical societies including in their work research in the antiquarian side of their subject. He then went on to say that experts in any particular subject are assuredly the right people to undertake such work. It is more or less in that category that I venture to come before you this afternoon, identified as I have been for the last twenty-three years with a textile print works in one of the suburbs of London, where textile printing was carried on before the industry was driven north to Lancashire and to Scotland.

For many years past I have been an eager collector of early Oriental fabrics. At first I found the designs a source of much inspiration in the development of my own work; then followed the spirit of investigation as to their origin and the method of their production, and in this work I appear to have struck, as it were, a field somewhat neglected by my contemporaries; for although some few writers and chemists have contributed articles on the processes adopted by the Hindus, they have not dealt with examples of the goods produced by the very complicated and laborious methods employed by the natives of India. It is only by such study one can appreciate how much the print industry of the world is indebted to India.

The collection on the walls contains a few examples of this industry—long since passed away—mostly produced in India, and some few in Persia, in the remote past. From the perishable nature of the fabrics such specimens are fast being lost to the world.

Some of these hand-painted calicoes are still to be found in the art and technical museums of Europe, and there are more in the private collections of professional designers. From inquiries I have made in India amongst art museums, it appears that no good specimens have been preserved in that country.

I am hoping that my research, and the publicity which this Society will give to the subject, may unearth some specimens from the archives of collectors whose ancestors were connected with the East Indies.

My first task will be to deal with the historical side of printing. I find that it is generally agreed, amongst those who have studied the history of printing, that the art of impressing and imparting a design upon cotton or linen in colours which will withstand washing, originated in India, and that whatever science there may have been in the art, when Europe was so largely supplied with the painted and printed fabrics of India in the seventeenth and eighteenth centuries, the chemical processes adopted by the Hindus at that period were the same in principle as those described by the elder Pliny, who wrote A.D. 70. Pliny's writings are the bed-rock from which all research of this nature begins.

He says, in referring to Egypt (Lib. XXXV. chap. 11): "Garments are painted in Egypt in a wonderful manner, the white cloth being first stained in various places, not with dyestuffs, but with drugs, which have the property of absorbing colours. These applications do not appear on the cloth; but when the cloths are afterwards plunged into a cauldron containing the dye liquor they are withdrawn fully dyed. It is wonderful that, although there be only one dye in the cauldron, the cloth is dyed of several colours, according to the different properties of the drugs which have been applied to different parts; nor can the colours be afterwards removed. A cauldron which would of itself only confuse the colours on cloth previously dyed, in this way imparts several colours from a single dyestuff, painting (or dyeing) as it boils." From this passage it is evident that the drugs employed to stain the cloths were different mordants, and that some knowledge of calico printing or dyeing was known by the Egyptians, acquired no doubt from Hindustan.

I shall now, at this stage, pass over fifteen centuries and deal with my subject from about the time when the several rival East India companies were instrumental in making known to Europe, amongst other goods, these printed and painted cottons. The first in the field were the Portuguese, they having reached the East Indies by way of the Cape in 1498. This route transferred to them much of the trade then in the hands of the Venetians and Genoese, by way of the old trade route through the Persian Gulf to Bussorah, Bagdad, and Aleppo, from whence, *via* Alexandretta and Beyrout, the merchandise found its way to Venice and other

parts of Europe. At that time Bruges was the distributing centre over Northern Europe, afterwards Antwerp, and later on, after the destruction of that city by the Spaniards in 1576–85, Amsterdam became the centre. For nearly a century the Portuguese held undisturbed supremacy of the Indian trade *viâ* the Cape. The early Dutch trade with India was indirect, and came through their connection with the Portuguese, who had, as I have said, diverted the Eastern trade direct to Lisbon by water. By an interdict in 1580, issued by Philip II. of Spain, the merchants of Amsterdam were precluded from trading with Lisbon. The energies of the Dutch were, in consequence, devoted to more direct intercourse with India. Merchant adventurers making successive journeys to the Indies eventually amalgamated in 1602 into one corporation, under the title of the Dutch East India Company.

In 1587, among the ships seized by Drake when the Spaniards were about to invade England, was the "St. Phillip," a Portuguese carrack coming from the East Indies. The papers of this vessel afforded much information as to the value of the Indian trade. In 1592 another carrack, the "Madre de Dios," was captured by some English privateers, who brought her to Dartmouth, and it is mentioned that amongst her cargo were calicoes, lawns, quilts, carpets, and other rich commodities. It was the capture of these vessels that determined the English to establish direct communication with India, and led to the memorial of the promoters of the London East India Company to Queen Elizabeth in 1599, to be followed in 1600 by the granting of its Charter. The French do not appear to have been in the field quite so early, and it was not till 1664 that Colbert, the Controller of Finances, induced his Sovereign, Louis XIV., to grant the Charter to the French East India Company.

Coming now to the references made by travellers and merchants on the subject of the prints under review, I find that in 1498 Odoardo Barbosa, one of the Portuguese adventurers who visited India immediately after the discovery of the Cape route, refers "to the great quantity of cotton cloth admirably 'pintadoed'" (painted—the word was later adopted as a trade phrase by the factors and officers of the Dutch and English East India Companies).

In 1563 Cæsar Frederick, who travelled to India *viâ* Bussorah, described the "extensive trade carried on between St. Thomay and Malacca in fine bumbast cloth (cotton) of every sort, painted, which is a rare thing, because these kind of cloths show as they were gilded with divers colours, and the more they are washed the livelier the colours will show."

In 1657 Boullaye-le-Gouz writes: "Hitherto it is not known how the natives apply so successfully the colours to the 'foyes' and *toiles peintes* in such a way that they lose nothing in the washing. I showed some in France to several dyers who were filled with admiration at them, assuring me that the dyes in India are pure and quite simple, whereas those of Europe are sophisticated (*alterées*)."

In 1693 Dr. Havart, M.D., a Dutch botanist, in a work entitled the "Rise and Fall of Coromandel," writes with much detail on indigo dyeing, and in the same work makes meagre reference to "the chintsen, which are painted at Palicol, after designs which are given to the painters, which they imitate very well, for the natives are so stupid that they are unable to produce anything original; but they can imitate and produce a perfect copy; but one chintsen is not always as good as another, although both may have been painted by the same hand . . ." In another passage he says: "They have at this place four kinds of painters, who have each his special duty, connected with the painting establishment, among whom the work is shared; they in their turn sublet the work to their subordinates, who actually do the work. These latter are mostly people without means, so that, in order to pay their debts and yearly poll-tax, they are obliged to work very laboriously or else they would be reduced to beggary. For this reason more chintzes are produced in Palicol than in the south. The painting of chintzes proceeds in the most leisurely manner in the world, in a manner similar to the crawling of snails, which appear to make no headway. Anyone who would represent patience, and had no other model, could use one of the chintz painters of Palicol."

The writer in another place has a few lines describing the painting process, but it is so vague and incomplete that I forbear to quote it.

In 1777 Abbé Raynal, who is the author of a work entitled "Histoire Philosophique et Politique," says, amongst other things: "Quite a colony of Europeans of various nationalities are located at Masulipatam. They are engaged in the export of cotton goods. They also buy the painted cottons, which, however, European printers have not the enterprise to copy.

"It will be an abuse of the reader's patience to trace the slow processes used by the natives

of India in the art of painting these cloths. They say they are due more to the antiquity of the art than to the fertility of their genius. There is one thing apparent in this conjecture, and it is that they have not advanced a single step in the art for many ages."

I propose at this stage to introduce the most important information we possess of a technical nature on the methods adopted by the natives. This is to be found in certain letters written by a Jesuit missionary at Pondicherry, Father Cœurdoux, to another Jesuit father resident in Europe. They appear in "Lettres Edifiantes et Curieuses," and are dated 1742. Briefly, they are as follows :—

"Take a length of half-bleached cloth and immerse it in a bath of buffalo milk to which is added the dry fruit of a myrabolan, called kadou, reduced to a fine powder. When the cloth is thoroughly steeped, withdraw, wring and put it to dry in the sun. The next day lightly wash in plain water, dry in the sun, and afterwards leave in the shade. This internal preparation is followed by an external one, having for its object the smoothing of the cloth, so that no obstruction is offered to the brush when they come to paint. This operation is to fold the cloth into quarters or sixths and then beat it with a smooth piece of fine grained circular wood, about the thickness of one's arm, upon another similar piece. This operation we know as beetling, and imparts to the cloth the smooth surface so necessary in the operation of pencilling or painting. The pleats are reversed and the operation repeated. Two men, seated opposite each other, beat the cloth as they think fit until appearance and experience lead them to know that it is sufficiently polished and smooth.

"The painter or artist, having prepared his design upon paper, next has to transfer it on to the cloth. He begins by pricking the main outlines of the design with a fine needle, then lays his paper on the cloth, and passes over it a pad containing charcoal powder, which, penetrating through the pricked holes, by this means transfers the main features of the design on to the cloth.

"The black is the first colour to deal with, and for this purpose I should describe its preparation. They collect a heap of iron filings and dross, which they subject to the heat of a fire made of banana leaves—which they prefer to any other fuel, presumably on account of their reducing action—to reduce any oxide present. When cool, the filings are placed in a vessel and hot rice-water liquor is poured over them — it is probable that this rice had been boiled some time previously and allowed to ferment and become acid. The solution is then exposed to sunlight, and later the liquor thrown away, and the vessel containing the iron is refilled with sour cocoanut-tree wine. The solution thus obtained is acetate of iron. The preparation is again subjected to exposure in the sun for several days, and is then ready for use in the form of an iron liquor, care being taken not to give an excess of iron, which has destroying properties. A good black is formed with the tannin or astringent of the kadou, already applied with the buffalo milk.

"Having pencilled in the design over the charcoal tracing with the iron liquor, wherever needed for black, the next stage is to subject the cloth to boiling water, to which some of the astringent kadou is now added in order to form a good deep black. The next step is to prepare the cloth to receive the blue, and for this purpose it is required to be freed from the astringent already applied, by inserting the cloth in a maceration of goat's or sheep's dung, well washing and drying in the sun; failure to do this would cause the blue when dyed to become black. Furthermore, the cloth at the beginning was half bleached, and the properties of the dunging are to help to whiten the cloth. The beating process already explained is repeated very profusely. The blue is not painted on with a brush, but a wax resist is painted over the whole cloth, except only in the places appropriated to blues and greens. Liquid wax is put on with an iron pencil, and when done the cloth is exposed to the sun and care taken that the wax penetrates to the other side of the cloth. The cloth is then sent to the indigo dyer to be dipped. When dyed the wax must be thoroughly removed by boiling the cloth in water, and when cool the wax which floats on the surface is skimmed off with spoons. Then follows dunging, hot-water washing with a sort of impure soda, or fuller's-earth, renewed steeping in dung, and beating about 400 times on a stone. The cloth is then strongly wrung out, and left for twenty-four hours in a maceration of cow's dung, to be followed by the usual washing and boiling processes. In this way it is rendered ready to receive the kadou and buffalo milk treatment as given in the first instance. The cloth is again beetled by beating, and in this way is gradually being prepared for the next dyeing operation—that of red. Then it is that wax is pencilled in,

as a resist, on all such places where fine tracery of white appears over reds and pinks and lilacs. The cloth is now ready to receive the red, pink and lilac mordants, and this is done, by applying Pliny's method of painting or pencilling in the various mordants, and afterwards dyeing the whole cloth in a red liquor bath. In this case the mordants employed, as described by the Jesuit father, were drugs composed of alum and certain kinds of hard water, obtained in Pondicherry, to which would be added japan wood, just enough to stain the emulsion when painting, as alum alone is invisible. The places on the cloth for reds would require to be painted with a stronger emulsion of alum than the places for pinks; whilst the violets would require to be painted with a mixture of alum and iron liquor, composed of the iron rust and the sour rice-water.

"The three varied mordants having been applied, the next step is to subject the cloth to a severe washing in water (which I conclude had alkaline properties, because he remarks this is the principal thing in sight, having for its object, so far as I can judge, the fixation of the alumina and iron). Then beat on a stone in order to remove certain of the greasiness occasioned by the buffalo milk, and to prepare it to more evenly imbibe the red dye liquor, which now forms the next operation. This bath is made up of tepid water with the roots of a plant called chay (*Oldenlandia umbellata*), reduced to a powder which has been treated with bitter water, and whilst the cloth now inserted is in the dye liquor it is brought to the boil; then it is taken out in order that the dyer may remove any stains or splashes of red which may be developing in their wrong places, owing to the carelessness of the painters when applying the mordants; for this purpose they use lemon juice. When this operation is done they return the cloth to the dye bath, increase the boiling, completing the operation by a gradual cooling down. After this the cloth is subjected to the same severe treatment of washing in various baths of dung and soap, exposed to the sun and watered occasionally until the whites are a good bleach, and the stain from the reds removed from such parts where it is not required.

"Yellow has next to be applied, and this is made up with a solution comprised of alum, myrabolan and the rind of pomegranate, which is painted or pencilled over places where yellow is required, and also where the blue already dyed is to be turned into green. The yellow, you will observe, is directly applied, and in consequence is the weakest of all their colours."

Before concluding, a word must be said as to the Indian pencils. They are nothing more than a small piece of bamboo, sharpened and split at the end for a distance of a finger-point.

These letters from Father Cœurdoux exhibit remarkable patience; he seems to have followed every process communicated to him by the natives with infinite detail. In concluding his letter he says: "What I have to tell you, my Rev. Father, has been acquired from various neophytes skilful in this sort of work with whom I have conversed since baptism. I have questioned them frequently and separately, and their replies I now send you."

A certain M. Poivre reviewed these letters, and, writing to Father Cœurdoux, says: "Amateurs in the art, not calico printers, but amateurs or beginners, should willingly acknowledge these new discoveries, which you have been able to furnish them with"—and then, asking for further information, he suggests that: "If you could possibly divest yourself for a short period of your apostolic zeal, you would render a real service to our *curieux* in Europe." He concludes his letter by saying that "it is surprising that no Europeans have striven to enrich their country on the subject of an art from which much advantage would accrue, and that it should be the desire of our travellers, in quitting their country, not to be forgetful that there are no people who are not in possession of some particular art, the knowledge of which would be useful to Europe, etc., etc. Up to the present, you, Rev. Father, and those who work amongst the Chinese missions, are the only travellers who have given an example of work so useful. The pains they have taken to discover the methods of the Chinese workers of porcelain, the cultivation of the mulberry and the nurture of the silkworm, have merited the thanks of all their countrymen, whom they have so well served. Why is so brilliant an example so little followed?"

Although I have been unable to find that these communications were made public till nearly twenty years after they were written, we may with safety conclude that certain printers had the benefit of the information imparted by the Jesuit missionary.

Although the letters I have quoted from Father Cœurdoux were rendered somewhat incomplete, either by reason of the Hindus not understanding the principle underlying the

success of the operation of dyeing the reds or else the difficulty the Jesuit father would have in interpreting their description of the processes, the general operations were undoubtedly of great service to the calico printers of Europe, as is evinced from the many text-books on the industry published between the years 1760 and 1800. Furthermore, the general operations formed the key to the process of madder printing, and, as madder was known in Europe at this period, this was the dye root used by European printers and dyers in the place of the Hindus' chay root.

Thus it will be seen how important a part does chemistry play in the production of these Indian painted cottons, and one might well ask, how came the natives of India to possess the knowledge of the art ? Were the secrets handed down to them from father to son, through those twenty centuries of civilisation which are credited to them ? Or was the art originally acquired by "some lucky chance, or from a slight and contemptible beginning," or have they "by long experience and curious observations and various improvements, matured and brought the art to perfection" ?

Whatever the beginning, certain it is that the art since evolved step by step in the manner recorded by the observant Jesuit father no longer exists; in fact, the Hindu dyer and printer to-day is entirely dependent on synthetic dyestuffs.

From the communications I have quoted, no less than twenty-six separate operations at least were needed to complete a chintz cloth, employing in its production a complement of such colours as black, red, pink, blue, green, puce and yellow, and this whatever size the piece of cloth.

The special feature in their production which must be emphasised is the fact that they were produced by the method technically known amongst textile printers as madder printing, and although the process was a long operation, the colours employed were few, and no modern method of printing in direct colours can produce them, so far as I am able to judge, so fine, so solid, and so beautiful.

It will now be my purpose to trace the influence of the Indian methods of calico painting on the print industry of Europe at the period under review, and in dealing with the word "painting" I should include printing as well, for although I have no specimen of these printed goods, we may safely conclude that the early cotton prints of two or three colours, particularly of small repeats in the design, which came to Europe through the agencies of the various East India Companies, were produced by block printing. Furthermore, it should be noted that in the Middle Ages the industry was well established throughout Asia Minor, where it is said to have been introduced from India by Armenians and Greeks. This I consider very probable, because Asia Minor offered every opportunity for a calico print country; it possesses its own cotton, alum, madder, yellow berries, pomegranates, galls, and other dyes. Furthermore, the Armenians were amongst the more important traders of the foreign communities in Madras, Calicut, Masulipatam, Guzerat, Ormuz, and other places. In the literature of the Levant, in the Middle Ages, and also amongst the records of the Dutch and English East India Companies, one is constantly coming across these traders, the following being a typical case taken from Mr. Foster's work on the English factories in India. Henry Barnford records an account of his journey from Agra to Tatta Mar, 1639: "Agra is little frequented unless by Armenian and Persian merchants, the commodity that took them there being only chints which are here made in good quantities, well collored, in appearance little inferior to those of Masulipatam, all of which commodities are by the Persians and Armenians transported to Spahan, and other parts thereabouts by the way of Candahar."

Amongst the examples now on the walls in this room we have evidence of the Armenians in the specimen entitled "Altar Frontal." You will observe an inscription at the base. This is in old Armenian characters, and from its translation we learn that it was dedicated "In memory of (the priest) Der Hohanes (John) and his parents Mikael (Michael) and Getsemani (Gethsemane) and his grandfather Hohan, and of Kafar, and his son Garabed, the Forerunner (that is, St. John the Baptist) and Bedros (Peter). In both bottom corners is to be seen the trade-mark of the H.E.I.C.

The history of the Armenian kingdom in the thirteenth and fourteenth centuries, with its colonies on the Mediterranean coast and Acre as its seaport, is full of interest. They were the commercial link between Europe on the one side and Asia on the other.

In like manner the Greeks introduced into Europe the Turkey-red process of dyeing, brought originally from India, and in this way we may readily understand the possibility of the art of printing filtering through Asia Minor westward into Europe, through the medium of

the Armenians and Greeks. The opening up of the East Indies round the Cape in 1498 would introduce a number of new dye products, and with them came also information as to their methods of use, which we may surmise were treated as trade secrets and not published to the world—in fact, there are indications in the communications from the Jesuit father that such was the case. We may also believe that amongst the first to communicate the processes would be the Dutch, for I find that amongst the earliest text-books are those of Holland.

As to England, I find that in 1619 a special privilege was granted to George Wood for twenty-one years, who has found "a waie to printe upon lynnen cloth." This process I regard as printing in oil or pigment colour for wall decoration, and my reason is that there is evidence that the earlier printings in England, Germany and France were such.

There are also the following letters patent—in 1624, to William Shipman, "sowing, selling and planting of the herabe, roote and plant called Madder."

1676, Will Sherwin, "new and speedy way for printing broad cloth, being the only true way of East India printing and stayneing such kind of goods."

1715, Peter Dubison, "printing, dyeing, or staining of calicoes in grain," which "shall equal if not exceed in beauty and use those stained in the Indies."

I think we may take 1676, which was the date of the patent to William Sherwin, as about the time to fix the date when the art of printing was introduced into England. Sir Josiah Child, a director of the E.I.C., in a pamphlet published in 1677, mentions that goods then coming over from India were for the purpose of being printed upon in imitation of Indian chintzes.

More direct evidence gives 1690 as the date of the first printing factory established in England, at West Sheen, now known as the Old Deer Park, Richmond, and about 150 ft. from the Thames. It is said to have been started by a Frenchman who came over from Holland, where he had taken refuge after the revocation of the Edict of Nantes in 1685. A large number of persons were employed at this establishment, both male and female. It is recorded that they were "a saucy and independent lot," and that Richmond was overrun by the calico printers.

Very soon after the Richmond establishment, we find a considerable printing works being carried on at Bromley Hall, on the Lee in Essex, followed by many others on the outlying streams around London.

Wherever there is good water and an abbey, there would also be found the whitster or bleacher, to be followed by the calico printer.

I find records of printers at Waltham Abbey, Merton Abbey, Mitcham, Wandsworth, Isleworth, Lewisham and Crayford.

The new industry of calico printing was just growing in importance, and had "taken on"; the chintzes produced by our people were for the home trade as well as for export. The industry was encouraged furthermore by the prohibition in 1700, by Act of Parliament, of the importation of the real article from India. This Act of William III. was intended to protect the English woollen and silk manufacturers from the competition of Indian goods. The weavers had all along manifested the greatest hostility to the use of printed calicoes from the East. In the year 1680 they mobbed the India House, in revenge for some large importations then made of the chintzes of Malabar. In spite of the prohibition and the excessive penalties of £200 imposed on smuggling, the imported goods found their way into the country. Fashion had to be gratified, and the greater the restrictions the more determined were the ladies to have their own way.

About this period quite a number of pamphlets were published on the subject. Some of these afford amusing reading, and from certain of them I will quote:—

The following passage occurs in "A discourse concerning East India Trade, showing how it is unprofitable to the King of England," by J. Cary; with observations by Sir Josiah Child, 1699. The writer is very furious against the trades in calicoes, as "India does not take our goods nor encourage navigation," etc., mingled with much doubtful political economy.

"Calicoes and wrought Silks are the things I chiefly aim at, and hope to make it plainly appear that those two Commodities do us more prejudice in our Manufactures than all the Advantage they bring either to private Purses, or to the Nation in general, and it were to be wisht the Wisdom of our Parliament would prohibit their been worn in England, else like the ill-favoured lean Kine they will destroy the use of our Manufactures. Few think themselves well drest till they are made up in Calicoes both Men and Women. Calico Shirts, Neckcloths, Cuffs, Pocket Handkerchiefs for the former, Head Dresses Night, Hood Sleeves, Aprons, Gowns, Petticoats and what not for the latter.

"As if the dead could not rest easie in their Graves if wrapt in our Native Commodities.

"One thing which I aim at in this discourse is to persuade the Gentry of England to be more in love with our own manufactures and to encourage the wearing them by their example and not of choice to give employment to the poor of another nation whilst ours starve at home."

A pamphlet entitled "The Naked Truth in an Essay upon Trade," published in 1696, informs us that—

"The commodities that we chiefly receive from the East Indies are Calicoes, Muslins, Wrought Silks, peper, saltpetre, indigo, etc. The advantage of the Company is chiefly in their muslins and Indian silks, and these becoming the general wear in England. Fashion is truly termed a witch; the dearer and scarcer any commodity the more the mode; 30*s.* a yard for muslins and only a shadow of a commodity when procured."

As Baines remarks in his "History of the Cotton Manufacture: "So sagacious and far-sighted an author as Daniel De Foe did not escape the general notion that it was not merely injurious to our weaving industries, but also a national evil, to have clothing cheaper from abroad rather than to manufacture it dear at home."

In his weekly review he thus laments the large importations of Indian goods:—

"The general fancies of the people run upon East Indian goods to that degree, that the Chints and painted calicoes which before were only made use of for Carpets, Quilts, etc., and to clothe children and ordinary people, became now the dress of our ladies; and such is the power of a mode as we saw our persons of quality dressed in Indian carpets, which but a few years before their chambermaids would have thought too ordinary for them; the chints were advanced from lying on their floors to their backs, from the cloth to the petticoat, and even the Queen herself at this time was pleased to appear in China Silks and Callico.

"Nor was this all, but it crept into our houses, our closets and bedchambers; curtains, cushions, chairs, and at last beds themselves were nothing but callicoes or Indian stuffs; and in short almost everything that used to be made of wool or silk, relating either to the dress of the women or the furniture of their houses was supplied by the Indian trade. Above half of the (Woollen) manufacture was entirely lost, half of the people scattered and ruined, and all this by the intercourse of the East India trade.—Jan. 31st, 1708."

The Act of 1700 did not preclude the plain cloths of India from being admitted into the country, under a duty; to which was imposed, in 1702, an excise tax of 3*d.* per square yard on all home-made printed calicoes, afterwards increased in 1714 to 6*d.* per yard. In spite of all these taxes our people had become accustomed to the use of printed calicoes; they were cleaner, offered a greater choice for the women of this country, they made dainty garments, and it is natural that the prevailing kerseys, serges and camlets, which formed the staple goods of the country, would suffer.

A new alarm was raised amongst the manufacturers, with the result that the legislators of that day, intimidated as would appear by the East London mobs, enacted in 1720 an absurd and summary law prohibiting the wearing of all printed calicoes whatsoever, either of foreign or domestic origin. The enactment proved a terrible blow to the rising industry, in that it confined the operations of the printers to the printing of linens and cloths with a linen warp and cotton weft.

The business continued to flourish though in a lesser degree, and was carried on almost exclusively in the suburbs of London, till after the middle of the eighteenth century, when a greater commercial revolution was in progress—that of Arkwright's spinning jenny, and Watt's improvement of the steam-engine. Gradually it had the effect of driving the industry to the North, to cheaper fuel centres, where, in conjunction with cotton-spinning and weaving, that new and brilliant era of machinery was in store for this country, which in time gave greater scope to the activities of the rising generation of calico printers.

About the period of 1714 to 1760 our printers had reached a degree of such excellency as to merit the praises of Jean Rhymer of Bale. He wrote a very valuable record of the earliest days of calico printing in Switzerland. He was a merchant and printer in Bale, and bought Indian goods in Holland and England, to be afterwards printed by himself in his own country and by others in Holland. He was of all men eminently qualified to judge, and his testimony I regard as most interesting, as it helps to place this country in the foremost position as printers at about the time he wrote. Amongst other things he says: "It was only at Neuchatel that the printers sought to combine glory with profit, and to make goods imitating the English

and Indian prints. Now the English had closely followed the Dutch in printing, and soon surpassed their teachers in excellency." In another passage he says: "It was reserved for the English to attempt an imitation of the best Indian work in prints, and to arrive at a degree of perfection which no one would have thought possible. All the world knows this people, whose industry and plodding patience in overcoming every kind of difficulty exceeds all imagination. This nation cannot flatter itself with having made many discoveries, but it may glory in having perfected all that has been invented by others. Whence the saying to have a perfect thing it must be invented in France and worked out in England."

Turning to France, the influence of these Indian goods, to which must be added the gradual creation of a new industry, led to chaos and much disaster in the history of that country. At that period, viz., at the middle of the seventeenth century, textile printing was not known in France. I gather from certain writers that some such industry existed in the Middle Ages, but as I am by no means satisfied as to the style of work it may have been, I will refrain from offering an opinion. Whatever the process, it is evident it was very limited in palette of colours, and that little by little the industry sank into oblivion. The real article from India appears to have revived the ancient industry, and many works and small *ateliers*, I read, were installed throughout the country, encouraged by Colbert, the Minister of Finance. The production in the early stages of the revival in no way resembled the real article, though they bore the name of Indienne. They were in the most part, so far as I can gather, printings by block and paintings by hand on various fabrics in pigment colours, just as one would print in these days upon wall-papers.

It is very clear that whereas our printers in the early days of the industry, 1690 to 1720, were printing on the lines of Indian methods, the French had not yet acquired any of those processes known as the madder style. It is the more remarkable, and makes it difficult for me to comprehend, how such faked goods, plus the importations of the real goods direct from India, and also through the intermediary of the English and Dutch Companies, could possibly upset the equilibrium of France's national industries. That they did is certain, and to such an extent that one writer, Edgard Depitre, says, in the preface of his work entitled "La Toile Peinte en France au dix-septième et dix-huitième siècles":—

"So much was written in the seventeenth and eighteenth centuries on the subject of *toiles peintes* as on the subject of cereals, that it occupied the central authorities, and inflamed the people; for three-quarters of a century it remained established a burning problem and created lively discussions; it was the object of two edicts, and some eighty decrees in council; at one time it became a State question; it divided France into two camps, gave birth to an abundance of literature, provoked passionate controversy, in which the best-known economists of those days took sides. It was, in fact, a question *furieusement historique*."

The question is interesting and requires that I should review the situation. Already in 1664, when the F.E.I.C. was founded, instigated as I have said by the Minister Colbert, the real goods were well established on the market. The French, we must understand, were in those days, as we know them in our time, the leaders of fashion, and the effect of these Indian goods having become not only universally fashionable, but also a necessity for purposes of decoration, the national industries of France suffered in consequence, in proportion to their export as well as to their home trade.

In 1683 the return cargoes of the F.E.I.C. comprised mostly *toiles peintes* and plain cottons, and produced £1,500,000, the company gaining 300 per cent. From 1675 to 1684 eight vessels returning to France with cargoes costing £1,870,000, realised in France £4,370,000; these *toiles peintes* being the most profitable of the company's imports. Already the silk and wool weaving industries had been provoked to great hostility, and now the article of another country (which in no way was reciprocal in its trading) had usurped, as it seemed to the French, their prerogative of supplying goods of fashion, and robbed the country of an export trade which had hitherto added to the national wealth of the country; furthermore, the importation of the Indian goods through the English and Dutch East India Companies aggravated the grievance. Drastic measures had to be taken to curb the increasing discontent of the manufacturers. For a long time past religious persecutions had precluded many skilled Protestant workmen from pursuing their regular vocations. It would appear that, in consequence, they occupied themselves in this new industry of printing Indiennes, which I have no doubt was not included in the barred occupations.

But a more severe blow was struck at the industry when, in 1685, the Edict of Nantes was revocated, since this industry, like so many other industries, was in the hands of the Protestants.

Notwithstanding the large exodus of workmen created by this enactment, it failed to improve the situation, and when at this period, on the arrival of a vessel at Rouen laden with large quantities of *toiles peintes*, the sale of home-made serges suddenly ceased, other measures had to be devised, and so a double decree was passed prohibiting the importation of all real Indian printed and painted goods, and also the production of all home-made prints, whether for wearing apparel or for decorative purposes. The decree further enacted that all printers were to cease work; printing blocks and all apparatus connected with the industry were to be destroyed. It also prohibited, under severe penalties, the wearing of chintzes.

The "Indiennes," as forbidden fruit, became the passion of the better class of women. They openly defied the law by establishing clandestine depots for the sale of these goods at Versailles and at Fontainebleau to serve the Court. The wives of Ministers who were expected to carry out the edicts were the first to break the law and wear the *toiles peintes*. Madame Pompadour, the Court favourite, furnished a chateau at Belleville with the contraband goods. The war lasted seventy-three years, and much property was destroyed and dire punishment enacted; but fashion in the end was the winner.

During all these years of inertia as calico printers, France had been slowly coming to the front as wool printers; and later, when the Government realised the uselessness of the struggle and decided in 1759 to annul the prohibitions, she was ready to take her place amongst the foremost calico printers of Europe, basing her work on the processes of the Hindus, and reproducing the designs of Persia and India. Very soon a hundred works were to be counted throughout the country, the best known and the one whose name was printed on the *toiles peintes* being that of Oberkampf at Jouy.

In Germany, in the seventeenth century, such printing as existed in that country was by block with pigment colours mixed with oil; gold and silver were also used. They printed on linens and pile fabrics for decorative purposes. The type of designs seem to have been Gothic and Byzantine. Owing to the strongly established German weaving industry, there does not at this time appear to have been a call for prints for wearing apparel. Towards the end of the seventeenth century English and Dutch prints began to be imported, and they threatened to swamp the German productions. About 1690 Neuhofer, a printer of Augsburg, seeing that his styles were being pushed aside, went to England and Holland to learn how printing was done in those countries. He came back, and after a certain amount of initial difficulty and opposition from the dyers, he made a success of these new methods and built up a large industry. The dyers opposed him when they saw that dyeing (madder dyeing) was part of his process; they said that he was infringing on their privileges. After him a great number of other concerns got to work on this, to them, new process of printing fast and washable colours. In 1759 Schüle, the most important of the Augsburg printers, was printing on cotton all manner of madder reds, browns, and violets, on white and coloured grounds, and he imported large quantities of cotton piece-goods from the East Indies *viâ* Holland for printing on. This incurred trouble from the local weavers' union, which brought legal proceedings against him.

I must now close my story. The subject covers a wide field with most interesting matter, which cannot be told in the short time at my disposal. I must, however, express a hope that some native student of India, preferably one interested in dyeing and conversant with the literature of his country, will make an investigation of this subject and place upon record full descriptions of how the natives of India came to acquire the methods recorded by the Jesuit father.

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DISCUSSION.

The Chairman (Sir William Martin Conway, M.A., F.S.A., F.R.G.S.) said that after the learned and interesting paper that had been read by Mr. Baker any remarks made by himself must naturally be those of a mere amateur and outsider. He had been very much struck by the philanthropic character of the paper; because, obviously, looking round the room at the beautiful collection of rare treasures Mr. Baker had acquired, he had had the market very largely to himself, but after the publication of his paper—and still more after the publication of the beautiful book he was preparing—he would have many competitors, and probably would never get another cotton cloth for himself again at any sort of reasonable price. The specimens were of a very high order of beauty as well as of very great rarity. With regard to the remark in the paper that the industry had absolutely died out in India, the horrible idea had occurred to him that it must have died out in consequence of contact with European civilisation. Still worse, it was awful to think that people who might be learning in their youth to make such beautiful objects were now being taught reading, writing and arithmetic, three useless things to those who were capable of such wonderful handicraft. The foundation of the art was obviously Persian, but probably tradition went very much further. He had seen in some of the museums in London, Paris, and elsewhere examples of coloured linens going back to the eighteenth Egyptian dynasty, or about 1500 B.C., and there were Coptic cloths of perhaps the fifth and sixth centuries A.D.; these he believed were not printed in colours but were all in monochrome. Fragments of printed linens, he believed also in monochrome, had come down from the Middle Ages, and there were examples to be found dating back to the fourteenth century, and possibly earlier. But none of those productions possessed the wonderful qualities produced by the elaborate system of dyeing which Mr. Baker had described. It was almost painful to hear the quotation of the writer who said that in the seventeenth or eighteenth century a thing had to be invented in France and worked out in England, because, as was well known, the process had been reversed in later years, great inventions being made in England and then being worked out in Germany—as, for instance, the aniline dye industry; the scientific part of that work was done in England, but the Germans reaped the harvest. After the war it was to be hoped that that condition of affairs would not be revived.

Mr. Alan S. Cole, C.B. (Member of Council), drew attention to the fact that the designs shown by the author were chiefly of a botanical or floral nature. A little while ago he was reading in Evelyn's Diary that he went to Ashstead to visit a certain Lady Mordaunt and found her room hung with "pintadoeds," in which were depicted Indians working at various trades and crafts. The idea of having incidents instead of floral designs was carried out very largely by the French in their *Toile de Jouy*. The author had made no reference to the difference between what was called *kalamkar* and *palampore*. He believed the word *kalamkar* came from the Persian word *kalam*, meaning a pen, and *kalamkar* referred chiefly to things done with a pen or pencil, while *palampore* he believed to be a generic term for things produced from stamps.

Colonel T. H. Hendley, C.I.E., asked the author whether he had examined the chintzes made near Jeypore, in Northern India. There the manufacture of chintzes had been going on for hundreds of years; there were specimens in the museum at Jeypore certainly two hundred years old, and a dress worn by a Maharaja in the seventeenth century. The designs were in great variety, and mostly done by block printing in different colours, but partly by the process described by the author of using various kinds of mordants and pigments. Some of the designs were very elaborate, and were both floral and figurative. The virtue of the chintz, its rosy groundwork, depended a good deal on the cloths being dipped in the river outside the town and dried on the banks. Some time ago a German, agent for a large firm in Manchester, went to Jeypore and studied the question, even taking away some of the water from the river; and a year or two later the markets were flooded with imitation chintzes, and the Jeypore industry was very much damaged. He did not believe the faculty of invention in the Hindu dyer had been lost; it had been overpowered, possibly, by commercial methods and the use of aniline dyes. In 1894 a conference in Lahore passed a resolution asking the Government of India to regulate the production of aniline dyes in the country, and it was pointed out at that time that Persia had been already ruined, but the Government never saw its way to doing anything in the matter. It seemed to him that the account given by the author applied also to a number of other processes in different arts, such, for instance, as enamelling. It was well known that India had borrowed from all the world from the earliest ages, picking up processes and bringing them to perfection. He would draw the author's attention to the fact that some very interesting articles on dyeing had appeared in the

Journal of Indian Art, which might be useful to him, but certainly none of them were so valuable as the address that had been given that evening.

MR. GEORGE C. HAITÉ, R.I., wondered what sort of reward or recognition the author would obtain for the sacrifice of time he had made and the trouble he had taken in bringing together such a magnificent collection. He was glad to know he was going to continue the work by bringing out a book; but unless he was a lucky man he was not likely to profit much in a pecuniary way, though no doubt his pleasure in the work would be a great compensation to him. He remembered that in the rooms of the Japan Society, some time ago, a gentleman lectured on Japan and the art of Japan, and around him, on the walls, he showed a collection of drawings of still life in the very best methods of early South Kensington. He had the audacity to ask for subscriptions to help Japanese artists to come to England and take lessons at South Kensington! The British people were generous, kind and brave, but in some things very stupid, and their stupidity meant a great lessening of their achievements in the world and a retardation of progress. He himself was a descendant of men who had been associated with the art of calico printing for many years, and he had been delighted to see the success which Messrs. Baker had made of the works at Crayford, where the very best printing was done, and which was really the Mecca of calico printers. He was glad to know that the subject was in such worthy hands, and to the author was due the thanks of all lovers of art and of the application of art to manufactures.

THE CHAIRMAN, in according the thanks of the Society to Mr. Baker for his paper and exhibition said a very great debt of gratitude was owing to Mr. Baker for what he has done.

MR. G. P. BAKER briefly described the specimens of printed calicoes on exhibition in the hall, and the meeting then terminated.

ARTS AND CRAFTS.

Artree Intarsia at the Medici Gallery.—The Medici Society has made somewhat of a new departure in opening its doors to a collection of Artree intarsia panels by Mr. A. J. Rowley. The work is not by any means unknown. It has been shown at various exhibitions within the last few years, notably at the British Industries' Fair, but this is the first time that it has been on view by itself at a well-known West End gallery. The panels are for the most part pictures—not painted with a brush, but formed of a mosaic of wood veneers of different colours and of great variety of grain. They are, of course, more or less in the nature of silhouettes, a few of them as frankly so as any picture cut out of black paper by the scissors of the silhouette artist. The most important pieces shown at the Medici Gallery were the three large compositions, "The Storm Cloud," "Homewards," and "Ghent," designed by Mr. Frank Brangwyn, A.R.A., all of which were planned with simplicity on definitely pictorial lines, and formed very effective pieces of decoration. Amongst other interesting and satisfactory pictures were some figure panels by Mr. W. A. Chase, suggesting French eighteenth-century work, which would be admirably in keeping with rooms of a certain type. It is not indeed as isolated units, that one feels these works must be judged, but as panels designed to fit into a scheme of decoration. One conceives of them, in the main, as forming part of the room, or gallery, or whatever it may be in which they will find themselves, rather than as pictures to hang on the walls—in other words, they are primarily decorative. That being so, one is conscious of some feeling of disappointment with the more obviously decorative of the works in Grafton Street. There was, it is true, a series of little mirrors ornamented rather in Japanese fashion which showed a good deal of taste, as well as a real appreciation of the qualities demanded by the method of execution, but some of the screens and trays adorned with flowers were rather garish in colour and not as satisfactory as they might have been, while the rolls of honour were none of them very good. This is the more to be regretted as the work would, if the right design could be found—not perhaps a very easy matter—be eminently fit for this use. Again, it would be interesting to see some of this intarsia which was not at all pictorial in aim. One can imagine that purely ornamental panels carried out in various colours, and with great attention to the grain of the wood, would be peculiarly beautiful in effect and would be useful in plans where more ambitious work would be out of place. Mr. Rowley's process has quite evidently not yet been made to do all that it can do. He is still feeling his way in order to find out how best it can be developed, but it promises well in many directions, and has already achieved good success. He certainly gets some pretty effects in the way of imaginative landscapes—it is noticeable that the places one knows best are always the least satisfying—and of simple figure work, and he has a real feeling for the quality of wood. It is to be hoped that his experiments will not lead him too far towards more elaborately pictorial rendering, but will take him in the directions of ornament, decoration, and severely simple silhouette work, where it looks as though a future awaited him.

Women's Work.—It seems as though since the outbreak of the war, while so many exhibitions and art classes have come to an end, there have been more exhibitions of women's work than ever before. That is not altogether surprising. To begin with, the increase is more apparent than real—it is only that the number is comparatively greater. Still, when hostilities first broke out

there was a good deal of dislocation in the employment of women, and consequently more need than usual to bring their work to the notice of the public, especially of that section of it with well-filled purses. Now that the dislocation has been in the main overcome, women are employed in all sorts of new callings and industries, and are anxious to inform the world at large of what they are doing and of the scope of their new undertakings; and so it comes about that shows of women's work go on being held in considerable numbers. The present-day exhibitions cover a very wide field of women's activities, and draw attention more particularly to such comparatively new openings as motor-driving and Red Cross work, but they contain also a surprisingly large amount of artistic and craft work. The British Women Workers' Exhibition, lately held at Prince's Skating Club, which described itself as an exhibition of the arts and crafts of the home-worker, was no exception to this rule. Side by side with more utilitarian work was to be found quite a quantity of artistic handwork, jewellery, needlework, weaving, basketmaking —and above all, toy-making. One of the points which these shows seem to emphasise most is the fitness of women for the making of artistic toys, and the exhibits at Knightsbridge—more especially the stall of Vale of Clwyd toys and that stocked by the North Warnborough Industry—were good examples of what women are doing in this direction. The most interesting embroidery was that sent by Mrs. Newall of Wylye, Wilts—mostly Greek or Oriental in type, some in plain white, some in black or red—which was excellent in execution and very tasteful in design. The cut leatherwork with an underlay of silk, by Miss M. E. Johnston was good; but it would have been rather more interesting had the leather and the material sometimes been in contrasting colours instead of practically matching one another. Weaving in excellent colour came from the Weaving School at Shottery, near Stratford-on-Avon, and good work from the Weaving Studio, Denmark Street, W. Competent rafia basketwork — as well as needlework—was sent by Queen Alexandra's School of Needlework, Sandringham, and the lamp-shades sent by one exhibitor made one realise that this work offered a field for really artistic work by competent women. While there was no work of striking and outstanding merit, the exhibition gave proof that women's work in the artistic crafts is going steadily on in spite of adverse conditions.

CORRESPONDENCE.

SUPPLY OF FOOD IN TIME OF WAR.

In your report of the discussion on Sir Henry Cunynghame's paper on "Supply of Food in Time of War," published in the *Journal* of May 5th, you omit the crucial point of my argument concerning the corn trade, and I would like to repair the omission.

After pointing out that dealing in grain is a very hazardous business, and that the amount of profit per unit of grain handled is exceedingly small, and after mentioning, as a rough and ready proof, that the price of bread in London before the war was only about half the price of that article in New York, I asked, who will be willing to trade in wheat on such terms or operate at all, if, immediately prices in the opinion of some authority are too high, a stream of wheat would be turned on from reserves accumulated in this country, with the object of reducing prices 5*s*., 10*s*., 15*s*., or 20*s*. per quarter? The argument may bring home to the readers of the *Journal* the danger of interfering with commercial operations conducted properly by individuals and firms. Any such action as that commended by Sir Henry Cunynghame must involve revolutionary changes in our methods of trading.

A. E. Humphries.

Coxes Lock Mill, Weybridge,
May 10th, 1916.

GENERAL NOTES.

Gum-Tragacanth in Persia.—According to a report by the United States Consul at Teheran, the various species of Astralagus, known in Persia as "kevin," from which gum tragacanth is obtained, grow on the mountain ranges which surround the Persian plain. The bushes producing the gum grow to a height of 2 feet. In the spring, when the sap rises, parts of the branches are cut away, thereby allowing the sap to flow out, which coagulates within a few hours on the surface of the stalk. The price of gum tragacanth has increased 5 to 10 per cent. since the outbreak of hostilities in Europe. The prices per lb. for the different grades of gum were at the date of the report (25th October last), as follows: First grade, 3*s*. 1½*d*.; second grade, 1*s*. 8*d*.; third grade, 1*s*. 2*d*.; fourth grade, 10*d*., and fifth grade, 6*d*. The principal Persian markets for gum tragacanth are Hamadan, Shiraz, Kerman, and Kermanshah. From 150 to 200 tons are exported annually from Hamadan alone. Before August 1st, 1914, half of this amount was shipped to Russia and the other half to America and the United Kingdom, but since that date the amount shipped to Russia has been reduced to one-fifth, the other four-fifths going to America and the United Kingdom.

Antimony Mines in Honduras.—Because of the advance in value of antimony incidental to the war in Europe, the profitable exportation of antimony ore or stibnite assaying about 70 per cent. has become possible from a mine in Honduras, said to be rich, but hitherto undeveloped because of unfavourable transportation conditions, and recently several small shipments of ore have been made from Puerto Cortes to New York. This ore is mined in the vicinity of the interior village of

Voro, and has to be transported six days by pack mule to the Sulaco River, thence two days by canoe down the river to Pimienta, where rail connection is made for Puerto Cortes. The mining and shipping of this ore under such difficult transport conditions, says the United States Consul at Puerto Cortes, is in accord with the claim that has often been made, viz., that the interior of this district was rich in minerals, and only needed railways for the development of the same.

MEETINGS OF THE SOCIETY.

(The times given are Parliamentary, not true.)

Ordinary Meeting.

Wednesday afternoon, at 4.30 p.m.:—

May 24.—John Collett Moulden, A.R.S.M., M.Inst.M.M., "Zinc, its Production and Industrial Applications." (Peter Le Neve Foster Prize Essay.) Dugald Clerk, D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

Indian Section.

Thursday and Friday afternoons, at 4.30 p.m.:—

June 1.—Professor Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India." The Right Hon. Lord Islington, P.C., G.C.M.G., D.S.O., Under Secretary of State for India, will preside.

June 23 (Friday).—Sardar Daljit Singh, C.S.I., "The Sikhs."

Cantor Lecture.

Monday afternoon, at 4.30 p.m.:—

J. Erskine-Murray, D.Sc., F.R.S.E., M.I.E.E., "Vibrations, Waves and Resonance." Four Lectures.

Syllabus.

Lecture IV.—May 22.—*Resonance.* Mechanical and electrical—Superposition of periodic impulses—Universal importance of the selective absorption of wave motions—Mechanical resonance or revibration—Screening of vibrations, absorption, and filtration—The acoustics of buildings—Sound resonators—Absorption of light waves—Coloured glass—Vision and photography—Absorption of electrical power by resonance—Tuning in telegraphy.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 22...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Dr. J. Erskine-Murray, "Vibrations, Waves and Resonance." (Lecture IV.)

East India Association, at the Institution of Civil Engineers, Great George-street, S.W., 4.15 p.m. Mr. H. Marsh, "Famine Protection Works in British Bundelkund."

Geographical Society, at the Alpine Club, 23, Savile-row, W., 3 p.m. Anniversary Meeting.

Medicine, Royal Society of, 1, Wimpole-street, W., 8 p.m. (Odontology Section.) Dr. J. H. Mummery, "The Structure and Arrangement of the Enamel Prisms, especially as shown in the Enamel of the Elephant."

Tuesday, May 23...Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Professor Mantoux, "World Relations and World Organisation—the Economic Aspect."

China Society, Caxton Hall, Westminster, S.W., 8.30 p.m. Mr. W. R. Carles, "Some Pages in the History of Shanghai, 1842-1856."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "Unconscious Nerves—their Functions in External Life." (Lecture II.)

Anthropological Institute, 50, Great Russell-street, W.C., 5 p.m. Dr. A. C. Haddon, "The Canoes of British New Guinea."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Mr E. G. Boulenger, Exhibition of living specimens of the African Lungfish (*Protopterus annectens*) and of their Cocoons. 2. Dr. R. Broom, "On the Structure of the Skull in *Chrysochloris*." 3. Dr. C. W. Andrews, "Note on the Sternum of a Bird from the Eocene of Nigeria." 4. Dr. A. Smith Woodward, "On a Mammalian Mandible from the Cretaceous of Alberta, Canada." 5. Mr. V. Lutshnik, (*a*) "List of Carabidæ (Coleoptera) collected in Chopersk District, South Russia"; (*b*) "A new Species of the Genus *Platysma* (Coleoptera) from China"; (*c*) "Notes on Species of the Genus *Platysma* from Australia."

Wednesday, May 24...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. J. C. Moulden, "Zinc, its Production and Industrial Applications."

Geological Society, Burlington House, W., 8 p.m.

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5 p.m. Mr. E. Gosse, "Catherine Trotter: the Earliest of the Blue-Stockings."

Medicine, Royal Society of, 1, Wimpole-street, W., 5 p.m. (History of Medicine Section.) 1. Drs. J. A. Nixon and C. Singer, "Miniatures of the Bristol Guy de Chauliac MS." 2. Dr. C. Singer, "Some Figures bearing on the Practice of Blood-letting in the Fourteenth, Fifteenth, and Sixteenth Centuries." 3. Mr. R. R. Steele, "Note on the Scientific Work of Roger Bacon."

Optical Society, at the Chemical Society, Burlington House, W., 8 p.m. Dr. P. G. H. Boswell, "Sands used in Glass-making, with special reference to Optical Glass."

Japan Society, 20, Hanover-square, W., 3.30 p.m. Mr. J. C. Hall, "Teijo's Family Instruction: a Samurai's Ethical Bequest to his Posterity (1763)."

Thursday, May 25...Linnean Society, Burlington House, W., 3 p.m. Anniversary Meeting.

Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander Mackenzie, "The Beginnings of the Orchestra and its Instrumental Combinations." (Lecture I.)

Friday, May 26...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor C. G. Barkla, "X-rays."

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Medicine, Royal Society of, 1, Wimpole-street, W., 4.30 p.m. Mr. J. L. Dick, "The Teeth in Rickets."

Saturday, May 27...Royal Institution, Albemarle-street, W., 3 p.m. Professor H. S. Foxwell, "The Finance of the Great War—How we stand to-day, and what lies ahead." (Lecture II.)

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FRIDAY, MAY 26, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

NEXT WEEK.

THURSDAY, JUNE 1st, 4.30 p.m. (Indian Section.) PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., Director of the Imperial Institute, "The Work of the Imperial Institute for India." THE RIGHT HON. LORD ISLINGTON, P.C., G.C.M.G., D.S.O., Under-Secretary of State for India, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 24th, 1916; DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, in the chair.

The following candidates were proposed for election as Fellows of the Society :—

Bilimoria, A. J., Navsari Buildings, Fort, Bombay, India.

Cropper, L. Cuthbert, F.C.A., Spencer House, South Place, E.C.

Waterbury, John I., 14, Wall-street, New York City, U.S.A.

The following candidates were balloted for and duly elected Fellows of the Society :—

Baddeley, Miss Mary, 113, The Crescent, Denmark-hill, S.E.

Banerjee, J. C., 21, Canning-street, Calcutta, India.

Driver, Robert Manning, Cowley, Horsell, Surrey.

Madden, S. Wilbur, 76, Sparks-street, Rangoon, Burma.

See Teong Wah, J.P., 10, Balmoral-road, Singapore, Straits Settlements.

Thomas, Miss Harriet E., 48, Clark-street, Newport, Rhode Island, U.S.A.

THE CHAIRMAN reminded the Fellows that the essay of which Mr. Moulden was about to give them a summary, since it was far too long to admit of its being read *in extenso*, was the result of a prize founded by Mr. Reginald Le Neve Foster in memory of his father. Mr. Peter Le Neve Foster was Secretary of the Society from 1853 down to his death in 1879, and though his own (the Chairman's) connection with the Society was of too recent a date for him to have any personal knowledge of Mr. Foster, he knew from the evidence of older members of the Council, who remembered his Secretaryship, that during his long tenure of office he had gained the respect and the esteem of the members. The Council had, he thought, been very well advised in their selection of a subject for the essay, because at the outbreak of the war the lack of supplies of the metal had been a grave difficulty in regard to the supply of munitions. They were fortunate in securing not only the admirable essay by Mr. Moulden but several other extremely useful compositions, one of which, the second best, was by Mr. Ernest A. Smith, the Deputy Assay Master of the Sheffield Assay Office, while another by an Indian Fellow of the Society—Mr. Ramji Das Vaishya, of Gwalior—dealt in a most interesting fashion with the treatment of zinc in the East Indies. He had very great pleasure in presenting to Mr. Moulden the medal which he had so deservedly won, and he hoped that the publication of so very complete a treatise on this important subject would have a beneficial effect in developing the production of zinc throughout the Empire.

The paper read was—

PETER LE NEVE FOSTER PRIZE ESSAY.

ZINC, ITS PRODUCTION AND INDUSTRIAL APPLICATIONS.

By J. C. MOULDEN, A.R.S.M., M.Inst.M.M.,

Member, Australasian and American Institutions of Mining Engineers.

I.—THE PHYSICAL AND CHEMICAL PROPERTIES OF ZINC.

Zinc is a metallic element of bluish-white colour and strongly metallic lustre, capable, particularly in the rolled form, of receiving high polish.

At ordinary temperature it is rather hard and brittle, a cast ingot of the metal being fairly easily broken across under a blow from a heavy hammer. The fracture is crystalline-hackly and of strong metallic lustre. Between 100° C. and 150° C. it becomes malleable and ductile, and at over 205° C. so brittle that it may be pulverised in an iron mortar.

It has an atomic weight of 65·37, and a specific gravity of 7·12, slightly increased by hammering. It melts at 419° C. and boils at 950° C., the vapour taking fire in air, burning with a characteristic blue-green flame and the production of clouds of zinc-oxide smoke. The metal also, particularly if in the form of shavings or wire, will burn in air at a temperature as low as 500° C.

It is very strongly electro-positive, and precipitates most other metals from solution—gold, silver, lead, copper, mercury, etc. It finds application on the industrial scale for such purposes.

Its thermal conductivity (silver 100) is 28·1, and its electrical 16·9 (mercury at 0° C. being 100). Its specific heat between 0° C. and 100° C. is ·09555 (Regnault).

It crystallises generally in rhombohedral forms of the hexagonal system, the size of the crystals depending upon the degree of purity of the metal, the temperature at which it is poured, and the rate of cooling.

Exposed to perfectly pure dry air or oxygen the metal does not tarnish, but under ordinary atmospheric conditions it gradually acquires a film of the whitish basic carbonate which protects the metal from further corrosion.

Zinc expands 11·1 per cent. by volume between the cold solid and the molten condition.

As usually met with and used the metal is very far from pure, and for preparation in a chemically pure condition special materials, methods, and precautions must be employed. The electrolysis of a chemically-pure sulphate solution, if effected with scrupulous care in every particular, will afford zinc of 99·998 per cent. purity.

Zinc forms with the acid radicles the usual metallic salts. The haloid salts, as well as the sulphate and oxide, find some application in medicine.

It has great affinity for oxygen, and forms one very stable oxide (ZnO), which is the most important zinc compound from every point of view, commercially and metallurgically.

At a red heat zinc is strongly oxidised, even by carbon dioxide, with the production of zinc oxide and carbon monoxide. Emphasis is laid upon this in that it constitutes a decisive factor in the metallurgy of zinc, and confines the practically applicable methods of extraction from its ores within very narrow limits.

II.—The History of Zinc.

Whether zinc *qua* zinc was known to the ancients is a much debated point, and until recent years the balance of evidence and opinion tended towards the negative. In view of the discovery of bracelets made of it in the ruins of Cameros, which was destroyed 500 B.C.,* it appears that it was known, however local this knowledge may have been. That it was not in common use is indubitable, and we are entitled to say that it played no part of any importance in the economics of the ancients.

The alloys of which zinc forms a constituent, particularly brass, undoubtedly were not only known but important. This alloy receives Biblical mention in Genesis,† where Tubal-Cain is referred to as "an instructer of every artificer of brass and iron," and again, rather more specifically, in Deuteronomy,‡ where the words "out of whose hills thou mayest dig brass" occur. Too much reliance must not, however, be placed on these as necessarily indicating the copper-zinc alloy known in later times under the same name.

It is of course well known that the first metal worked by man was copper, and the time when it was first alloyed with other metals was long before the dawn of history. There are frequent references to copper, bronze and brass in the earliest classical writings, the metal and its alloys alike being generally designated by the same name. Hesoid and Homer both mention it. Aristotle,§ writing in the fourth century B.C., tells us that the Mossynoeci—an Asiatic race mentioned by Herodotus as living near the Black Sea, in the neighbourhood of Colchis — produced a brass which was very brilliant and white; it did not contain tin, but a certain earth which existed there was melted with it. He adds that as the inventor had not instructed anybody in the method of preparation, the secret of its manufacture was lost. Later on, Pliny ‖ (first century A.D.) described at considerable length the various bronzes which were used for artistic purposes, and says

* Raoul Jagnaux, "Traité de Chimie Generale," 1887, II. p. 385.

† Genesis iv. 22.

‡ Deuteronomy viii. 9.

§ Aristotle, "Mirabiles Auscultationes," 62. (See "Scriptores Rerum Mirabilium Græci," A. Westermann, 1839.)

‖ "Hist. Nat." XXIV. A sufficiently full account of Pliny's descriptions will be found in Smith's "Dictionary of Greek and Roman Antiquities"—article "Aes."

that they contained varying proportions of tin, lead, gold and silver. On the whole it can only be said that while it is known from various analyses that zinc, either accidentally or of set purpose, was a constituent of some of the alloys, there is little evidence, beyond that given above, to show that its existence in the metallic state was known in classical times. On the other hand it may certainly be assumed from the descriptions, vague as they are, that the method of cementation was employed in the production of some, at all events, of the copper alloys.

At the time of the Roman Empire it was well known that certain "earths" had the property of imparting to copper a golden yellow colour, corresponding to what would to-day be a low-zinc brass. The word "aurichalcum" has been considered to be evidence for this, but it seems certain that this is really a mis-spelling due to false etymology. The Latin word *orichalcum* comes from the Greek ὀρείχαλκος, "mountain-bronze," and has nothing to do with *aurum*, gold. It is indeed possible that the resemblance of orichalcum to gold led to the wrong spelling. It appears that the word came at last to denote brass, not bronze, and Cicero tells us that coins of it were indistinguishable in appearance from gold coins. That certain Roman coins were made of zinc-copper alloy is also known by analysis.

Dana* sapiently observes that "as the use of aurichalcum dates from before Pliny's time, we moderns may as well let it stand without correction." It may have been the case that the alloy was, in the primary instance, produced direct from the ore, the basic carbonate of zinc and copper aurichalcite, or that the mixed oxidised ores of the metals provided the source. We know that aurichalcite was a product of the lead-zinc mines of Laurium in Greece, not far from Athens, and that it also occurred in Sardinia and Cyprus—the latter a very ancient source of copper, and later of zinc. Since the Laurium deposits were worked in very ancient times, and on an extended scale, for their silver and lead, and subsequently for zinc, they may well also have provided the means for the production of brass at one operation.

Experimenting at Broken Hill, N.S.W., some years ago, the author had no difficulty in repeating the experience of Sage† by smelting brass direct from aurichalcite associated with copper carbonate, the mineral being ground, calcined, and then reduced with charcoal in a crucible heated by an assay wind-furnace.

Whatever the means adopted for its earliest production, there is little doubt that the only method of which any real record is handed down to us is that of cementation, whereby metallic copper was heated in the presence of calamine and carbon, and the zinc so reduced alloyed itself directly with the copper. This method survived until quite modern times, that famous and accurate observer, Dr. John Percy,* recording that he had seen the process in operation at Birmingham so recently as "a few years before 1861." He gives also what is probably the most accurate and detailed description, accompanied by cost details, of the manufacture of calamine-brass preserved in our metallurgical literature. Percy also quotes several analyses of brass coins of the Roman era.

Although Paracelsus, who died in 1541, wrote of zinc as a metal, it seems first to have been actually recognised in Europe in the metallic form by Georgius Agricola,† who, about the middle of the sixteenth century, discovered it accidentally in the wall-crevices of a smelting-furnace treating lead and copper ores at Goslar in the Harz.

Percy records a similar case, from South Wales, of the condensation of zinc in the wall-crevices of a blast-furnace smelting zinciferous iron ore, and the author has also personal experiences of two such occurrences—the one in a lead blast-furnace treating a highly zinciferous charge, at Cockle Creek, N.S.W., and the other in a large electric furnace smelting zinc ores, where the metal condensed in masses weighing many pounds, forcing apart the joints of the firebrick lining to an astonishing degree. Agricola's discovery, therefore, receives strong corroboration in modern experience. He called it "conterfey," but did not recognise any particular mineral from which it was derived, this being reserved for Glauber, who in 1657 announced that calamine was an ore of zinc.

Henckel in 1721 stated that zinc could be obtained from calamine; but he published no details beyond suggesting "phlogiston" as the reducing agent.

None of these discoveries resulted in any tangible outcome, and the indirect manufacture of brass by cementation became more and more

* "System of Mineralogy," Sixth Edition, 1893, p. 299.
† Sage, "Journal de Physique," Vol. XXXVIII. 1791.

* Percy, "Metallurgy of Copper, Zinc, and Brass."
† Agricola, "De Re Metallica," 1556. Also translation of same by H. C. and L. H. Hoover, pp. 408-410, which contains a full discussion of the early history of zinc, London, 1912.

important. Thus we learn that about the middle of the seventeenth century calamine-brass works were erected in Surrey by Demetrius, a German, at an outlay of £6,000,* and that a "good profit was realised," whereupon British and foreign merchants combined against the proprietor, and involved him in heavy lawsuits, which caused his ruin and the abandonment of his works, "to the unspeakable prejudice of the kingdom." From all of which we see how really advanced, even in those days, the methods for "capture of trade" were.

Notwithstanding the use in alloyed form, therefore, from a very early period, the discovery and extraction of zinc itself were reserved for comparatively modern times, and we arrive at the latter end of the eighteenth century before we can credit Europe with tangible knowledge of the art.

For all this, it is generally recognised that the Chinese must have produced the metal at a substantially early date, although we have no specific details as to where or how. Specimens of Chinese and East Indian zinc were brought to Europe under the name of "tutanego," and we are even told that, some years prior to 1640, the Dutch captured a Portuguese ship with a cargo of zinc, which was sold under the name of "spiauter" or "spialter."† As to the extent of the cargo we have no record, and the story, if true, is an interesting historical forerunner of the extensive capture of zinc-ore cargoes effected by our Navy in the present great war.

Beckmann, who dealt with the history of zinc‡ rather fully, further records that the commercial company in the Netherlands between 1775 and 1779 caused to be sold on their account above 943,081 lb. of spiauter, and that in 1780 the Chamber of Rotterdam alone sold 28,000 lb. In 1781 the Danish company at Copenhagen purchased 153,953 lb. of "tutenage" which had been carried in two vessels, and which was sold "at the rate of 4⅛ to 4¼ schillings Lubec per lb." He states that it came from China, Bengal, Malacca and the Malabar coast, and one is tempted to wonder whether the whole of the quantities recorded comprised zinc. Robert Boyle coined the word "speltrum"§ from the term variously written as spiauter, spialter, spiautre, speautre or speauter, but he does not appear to have confined its use to zinc alone. Nevertheless we have obtained our English word spelter.

However all this may be, the metal introduced from the East does not appear to have been in sufficient quantity to exercise any substantial influence in the arts or commerce, but may possibly have had one far-reaching effect in that it is related that, during the first half of the eighteenth century, an Englishman journeyed to China and there learned the art, returning with his knowledge to England. It is frequently stated that the traveller was Dr. Isaac Lawson, but Percy* raises a doubt as to this. Bishop Watson† relates that in 1743 John Champion established at Bristol the first zincworks, having in 1739 taken out a patent, which although relating to metals had no reference to zinc.*

No doubt appears to exist that Champion was the first to erect zincworks of which we have any historical record, and to start the extraction of the metal on a substantial scale, nor that he, in 1758, secured a patent of great historical interest to us, for the winning of brass and zinc from blende as a substitute for calamine. Bristol had been a centre for the manufacture of calamine-brass since 1702,* and was also a producer of glass. Champion, availing himself of the calamine and a glass-furnace, worked out the zinc problem and established the so-called English method of distillation from large pots *per descensum*, keeping for a long time the actual details in that closely-guarded secrecy which persisted, with respect to the inner details of the metallurgy of zinc—more in reality as a pleasing fiction than an actual fact—right through to comparatively recent years.

There existed in the eighteenth century two very important known and worked deposits of calamine in Europe—one at Moresnet in Belgium, and the other near Beuthen in Poland. Both of these places were noted centres for the manufacture of brass by cementation, as also for the export of calamine for a like purpose, and it was more or less a natural corollary that the industry of zinc-smelting, as it became known, should follow.

Accordingly, towards the end of the eighteenth century the art, most probably learned in England, was carried eastward by Johann Christian Ruberg,‡ who, about 1799 or 1800—

* Percy, *op. cit.*

† Beckmann, "History of Inventions," London, 1814 (translation), Vol. III.

‡ *Op. cit.* Vol. III. pp. 71–99.

§ *Op. cit.* Vol. III. p. 98.

* Percy, *op. cit.*

† Watson, "Chemical Essays."

‡ Dr. L. von Wiese, "Beitrage zur Geschichte der Wissenschaftlichen Entwicklung der Roh-Zink Fabrikation," Jena, 1903.

some fifty years or more after the establishment of the Bristol works—established a smeltery at Wessola, in Poland, utilising, like Champion, glass-furnaces fired by wood for his earliest work. Ruberg did not, in the primary instance, avail himself of the calamine which lay so near his hand, but of the so-called "zinkstuhl," or rich zincy concretions which in those days—as indeed they still do—formed at the throats of the blast-furnaces smelting zincy iron ores, and incidentally caused a good deal of trouble to the ironmaster. He very soon found that the method of distillation *per descensum*, as practised at Bristol, was very defective, and thereupon evolved the system of treatment in horizontal muffles of large capacity,* thus laying the foundation of what was to become, in later times, the immense Silesian industry.

Almost coincident with Ruberg's work, zinc distillation from calamine was instituted by Dillinger at Dollach, in Carinthia, in 1799. This, although of some historical interest, had little influence on progressive metallurgy.

By 1805 the industry had advanced so little that in the year named the output of the Wessola works was 12½ tons of zinc only, the cost of production being £36 per ton, and the realised value £42.†

The calamine deposits at Moresnet passed in 1795 under the suzerainty of France, and Abbé Dony, a chemist of Liége, after many years of experimental work and the grant of the Moresnet concessions under the seal of Napoleon, seems to have quite independently discovered the distillation of zinc. There is no evidence that Dony had any knowledge of what had been done by Champion and Ruberg, and it is curious that, with Belgium separated only from England by a narrow strip of water, the secret should have been carried from Bristol so far east as Poland to commence with.

Various stories—pretty, even if not founded on strict fact—are related concerning Dony's discovery. One is that he received the "command" of Napoleon to evolve a method of extracting the metallic contents of calamine, and thereupon performed the rare feat of accomplishing a great metallurgical discovery "to order"; the other that, having inserted a flower-pot to act as a peep-hole in a reverberatory furnace treating a charge of calamine and coal, the zinc vapour condensed in the flower-pot and trickled down as fluid metal. It would be regrettable were we compelled to divest so technical a subject of its romance, and at that it were perhaps better to leave it. Certain it is that Dony, in 1807, established works at Liége, which formed the corner-stone of the Western European branch of the industry. He, by distillation in a number of small retorts set in a single furnace, gave us the Belgian method of extraction in contradistinction to the Silesian already referred to.

In 1805 the very important discovery was made by Hobson and Sylvester, at Sheffield, that between 100° and 150° C. zinc became malleable and ductile. This step forward was destined to exercise material influence by permitting of the utilisation in sheet form of large quantities of the rolled metal.

Nevertheless, the establishment of the means of commercial zinc extraction was one thing, and the fitting of the metal into its niche in the world of art and commerce was another. As might be expected, the brass-makers evinced at first indifference, and even hostility, to the new metal, averring that it produced brass inferior to that by cementation, and its use for this purpose extended but slowly.

The earlier of these objections were quite possibly well founded. It is by no means, apart from other considerations which enter into the matter, to be taken for granted that brasses of the same ultimate analysis, but produced in different ways, are necessarily of the same character or appearance. The method of preparation and the temperature at which the alloying is carried out, no less than the subsequent thermal treatment of the alloy, profoundly affect the characteristics of the resultant. Much of the calamine-brass was produced at a temperature sensibly below that of the melting-point of copper, while practically the whole of the modern brass made by the direct method is the result of thermal operations at a temperature well in excess of that point. The manufacture of the alloy by cementation does not, we realise, lend itself to the production of a high brass, nor is it economical; but, given pure materials, it has afforded some beautiful examples for the craftsmanship of the artist-worker in metals—well known to all who have handled many examples wrought from calamine-brass.

This chilly reception retarded progress, and for some years the industry remained a struggling one owing to lack of popular use for its product.

The good Abbé Dony suffered the fate which befalls many pioneers, in that he died a broken

* Lodin, "Métallurgie du Zinc," Paris, 1905.
† Liebig, "Zink und Cadmium," Leipzig, 1913.

man amidst penurious surroundings in 1819. He had, however, laid down the first rolling-mills at Liége in 1812, and three years prior to his death admitted as partner M. Dominique Mosselmann, a man of great energy and capacity, who took over the works, carrying them on until his decease in 1837. Even then the business was a tender fledgling, but his successors, with a capital of 7,000,000 francs, founded upon it the Société de la Vieille Montagne,* destined to become in modern times, with its world-wide ramifications, the greatest single producer in Europe.

It is recorded that the price of zinc in September, 1809, was 3.60 francs per kilo, falling the following year to 2.40 francs.†

The enterprise at Bristol, unsupported by any important local deposits of calamine, and handicapped by methods of working inferior to the Belgian and Silesian, languished and died out about 1860. Meanwhile, the well-known firm of Vivians had, in 1835, erected works at Swansea in South Wales, around which, as a nucleus, grew the Welsh branch of the zinc-smelting industry. This, limited as it is, remains to-day our Empire's greatest producer, and one may be permitted the hope that we are, for urgent national reasons, destined at no distant date to see radical changes in this respect.

The United States of America made no serious attempt to found zinc-smelting until 1850,‡ but once inaugurated it developed rapidly, and in 1909 placed that country at the head of the world's producers.

In so brief a review it is not possible to deal in any way exhaustively with every historical claim and detail, but an attempt has rather been made to indicate in logical sequence the salient features and successive steps which led up to the art as we to-day know it. Zinc has no history in the sense in which the precious metals, iron, lead, and copper, possess it. Practically unknown, save to a few, until the middle of the eighteenth century, it attained no great importance until certainly the first quarter of the nineteenth.

The nomenclature of zinc is a little confusing. The British usage, and also to a certain extent the American, is to apply the term "spelter" in designation of ordinary ingot zinc of commerce, the word "zinc" being usually reserved for the rolled metal and for chemical and mineralogical terminology. The miner thus sells ore to the smelter on the basis of its zinc contents, and the latter markets the extracted metal as spelter, which is not "a metal" *in sensu stricto*, but a commercial alloy produced by the smelting of zinc ores, and, although consisting mainly of zinc, containing usually sensible proportions of lead and other metals.

Recent usage, so far as Britain is concerned, has inclined towards the use of the word spelter for all grades of metal up to those containing 99·8 per cent. of zinc or thereabouts, those of higher quality than this being designated "fine-zinc." Although arbitrary, there are commercial reasons for the distinction.

III.—Zinc Ores, their Nature, Occurrence and Distribution.

Zinc is the proletariat of the common non-ferrous metals and, true to its class traditions, is by no means easy to extract from its baser surroundings.

Its ores are geographically very widely distributed—so widely indeed, that it is rarely that they are absent from any mining district which is a producer of the base metals. Particularly are they associated with the ores of silver, lead and copper, often forming huge deposits of considerable complexity, and presenting problems to the metallurgist, for the solution of which patents innumerable exist, still providing happy —or unhappy—hunting grounds for the fertile inventor of to-day.

The potential sources of zinc being so abundant it is certainly due to no scarcity of raw materials that its market value is, in normal times, relatively high. Between these potential sources, however, and the merchantable metal Nature has imposed a gulf, to be bridged only by the employment of very technical methods, in works requiring the expenditure of heavy capital for a relatively restricted output, and abundant supplies of skilled and semi-skilled labour for operation.

Many are the technical difficulties imposed upon the metallurgist by reason of the chemical and physical limitations of the metal, and the consequent necessity for the employment of ores relatively high in zinc content. Most of them have, therefore, to undergo some preliminary process of concentration before passing for metallurgical treatment strictly speaking.

The chief commercial ores of zinc are the sulphide—zinc blende or sphalerite—and the class of oxidised compounds usually designated under the generic term of calamine, such being used metallurgically for the oxidised ores of the

* "Official History of Vieille Montagne, 1837-1910."
† *Ibid.*
‡ Ingalls, "Metallurgy of Zinc," New York, 1903.

carbonate class (Smithsonite), hydrozincite and the silicates (Hemimorphite and Willemite). In the U.S.A. the native oxide (zincite) and the mangano-ferrate (franklinite) are also of importance as ores of zinc and sources of zinc oxide.

Zinc-bearing Minerals.

The principal zinc-bearing minerals and their content of zinc when pure are as follows:—

Mineral.	Composition.	Zinc.
		Per cent.
Blende . . .	Zinc sulphide	67·15
Smithsonite . .	Zinc carbonate . . .	52·00
Hydrozincite .	Hydrous basic zinc carbonate	57·10
Willemite . .	Zinc silicate . . .	58·10
Hemimorphite	Hydrous zinc silicate .	53·70
Zincite . .	Zinc oxide	80·25
Franklinite .	Zinc mangano-ferrate.	16 to 21

It is unusual to find any of the above alone constituting an ore of zinc, the latter most generally presenting a complex aggregate of zinc-bearing with other minerals and gangue, or worthless material, often requiring mechanical concentration for the removal of the undesirable constituents before a product of sufficient commercial value can be offered to the zinc-smelter.

Zinc-Blende — ZnS — contains, when pure, 67·15 per cent. of the metal, but is usually contaminated with iron manganese and baser substances, so that, in the form in which it is supplied to the zinc-smelter, it usually contains only from 35 to 55 per cent. of zinc. The more complex ores very commonly contain sufficient amounts of silver and lead also to render the residues, after extraction of the zinc, profitable commercial sources of those metals. Particularly is this the case with the ores from Broken Hill, N.S.W.

Smithsonite, the carbonate of zinc, was one of the earliest ores employed in zinc-smelting, and although the bulk of the metal is to-day derived from blende, it is still of considerable importance. It contains, when pure, 52 per cent. of zinc, but more generally, in the deposits in which it is commercially exploited, ranges much lower, owing to the admixture with silica, lime and iron. Ores containing as little even as 13 per cent. zinc are worked in Silesia by local smelters, such being too poor, of course, to bear the cost of transport. On calcination it loses the bulk of its carbon dioxide, and it is customarily calcined before distillation, the more particularly as it thereby loses considerably in weight, and becomes relatively enriched in zinc, this varying with the original composition of the ore.

Hydrozincite is a basic hydrated carbonate of zinc. Between it and Smithsonite there is, metallurgically speaking, little calling for comment.

Willemite is anhydrous silicate of zinc. The best-known deposits of it occur in New Jersey, U.S.A. In its pure state it contains 58·10 per cent. of the metal, but manganese and other base constituents are usually present and lower the value materially.

Hemimorphite is a hydrous silicate of zinc containing, when pure, 53·7 per cent. of the metal. It is not widely distributed in deposits of such economic importance as blende and smithsonite; but in Virginia and Missouri, U.S.A., and at Aix-la-Chapelle and Moresnet, in Belgium, it has been extensively worked, the latter two deposits being now practically exhausted. It is noteworthy in one respect in that the Virginian occurrence provided the source of one of the purest brands of zinc in the world, obtained by ordinary distillation methods direct.

Zincite (the native oxide of zinc), in a condition of purity containing 80·2 per cent. zinc, and franklinite (the mangano-ferrate), of variable composition, but with as a rule about 12 to 18 per cent., are important also, although of local significance, practically the sole worked deposits being in New Jersey, U.S.A.

Franklinite, owing to its composition, is worked mainly for the production of zinc oxide on the blowing-up grate, the residues being smelted for Spiegeleisen in the blast furnace.

Another source of the metal, although not an ore, consists of the zinciferous flue-dust which results from the smelting of iron and manganese ores containing small quantities of zinc. In available quantity it does not approach the ores previously referred to, but is an interesting metallurgical example of how the treatment of an iron ore, valueless as such from the point of zinc, results in a bye-product containing often as much as 75 per cent. of the latter metal and correspondingly valuable. It is produced by many of the iron blast-furnaces in our own country; and in the works at New Jersey, U.S.A., smelting franklinite residues it is a most important bye-product.

The geographical distribution of zinc ores in quantities of such magnitude as to warrant exploitation for their metallic contents is so

wide that reference to specific occurrences must necessarily be abbreviated, and then apply only to the more important of them.

In Great Britain zinc ores are being worked on a moderate scale, the best-known deposits being those in Flintshire, Cardiganshire, Durham, Cumberland, Derbyshire, and the Isle of Man, where they occur generally with those of lead, and are worked for both metals, being subjected after mining to crushing, concentration, and separation. Blende is the chief source of the metal, as exploited from our domestic deposits, the total production from which was, in 1913, 18,073 tons. It is not particularly creditable to our industrial organisation that a considerable part of this passed to the Continent for treatment, whilst our imports of zinc continued in ever-increasing quantities.

Australia has, in recent years, become a huge ore producer, although very little is smelted in the country itself; practically the whole is derived from the famous Broken Hill mines in New South Wales, the discovery and working of which provided one of the many romantic histories of mining. The material as exploited, from a huge lode deposit in places 300 ft. wide, consists of a complex association of galena (lead sulphide) and blende, interspersed through a gangue mainly composed of rhodonite (manganese-silicate), quartz, and garnet. It is also highly argentiferous. It is crushed and concentrated to remove the bulk of the silver-lead contents, the residue from this operation being dealt with by further methods for the production of zinc concentrates containing still some lead and silver. The real development of the zinc side of the industry was due to the discovery of the now well-known process of concentration by flotation, the similarity of specific gravity between valuable mineral and gangue having rendered abortive all previous attempts by the ordinarily accepted methods.

In normal times the Broken Hill deposits are capable of yielding within measurable distance of half a million tons of zinc concentrates annually, but, owing to the war and the consequent lack of available smelting-plants for their treatment, the restriction of output has been great. The quantity referred to would yield roughly no less than one-fifth of the world's annual output of zinc, and the enormous importance of this source, our Empire's greatest, may thereby be gauged. The ascertained life of the chief Broken Hill producing mines is also such as to assure the future production, although on a gradually reduced scale, for some years to come—probably ten as a minimum—even if no further ore bodies be developed. The whole of this is won from an area about three miles in length and less than a quarter of a mile wide, and this alone renders the deposit absolutely unique in the history of zinc-mining. A typical analysis of these Broken Hill concentrates as delivered to the metallurgist may here be given:—

	Per cent.
Zinc	46·50
Lead	8·50
Iron	7·60
Manganese	1·60
Sulphur	28·50
Lime	0·90
Cadmium	traces
Silica (insoluble)	4·50
Alumina	0·40
Copper	0·18
Oxygen / Organic matter and loss	1·30
	99·98

Silver, 15 oz. per ton.

Broken Hill produces no calamine.

South Africa possesses one known deposit—the Rhodesian Broken Hill—of some note, consisting largely as it does of a mixture of carbonate of lead with the carbonates and silicates of zinc, but transport and technical difficulties have so far prevented its appearance in the ranks of notable producers.

In Burma, active development operations are in progress, under which vast deposits of silver-lead-zinc ores of the sulphide class are being opened up at Bawdwen in the Northern Shan States, Upper Burma, some sixty miles only from the frontier of the Chinese Province of Yunnan. They are remarkable on several grounds, not the least being the high silver ratio and the comparative freedom from gangue, the crude ore as mined containing often as much zinc as the Broken Hill concentrates, with substantially greater quantities of lead and silver. While it is as yet too early for these deposits to have influenced the world's supply of zinc, the promise they bear of doing so in marked degree in the near future cannot be overlooked.

Canada and British Columbia have appeared in recent years as ore producers, although not in substantial degree. Such output as there is the American smelters have in the past absorbed, but recent proposals for the fostering by the State of the zinc industry in the Dominion of Canada invest the subject with a new interest, and render it highly probable that the exploitation of known deposits and the search for new ones will receive a marked stimulus.

The principal deposits of zinc ore situated within our Empire having thus been briefly outlined, the remaining countries of note in this connection may conveniently be referred to in alphabetical order.

Algeria (with which we may for convenience bracket Tunis) is a considerable producer of calamine, most of which, shipped from the ports of Bona and Sousse, found its way to Belgian, French, and German smelters.

Austria contributes modest amounts of zinc ore from her mines in Carinthia and the Tyrol, but in Hungary mining for the metal is almost unknown. The Austrian mines afforded, in 1913, 34,674 metric tons.

China—one of the earliest producers—has important deposits of both calamine and blende in the south-west provinces, chiefly Kweichou, and large quantities of zinc ores occur in the prefectures of Hêng-chou and Yang-chou. She also smelts to a limited extent, actual figures of output being difficult to ascertain.

France is a moderate producer, but much of the ore she smelts is of foreign origin. Her domestic production of ore in 1912 was 45,700 metric tons.

Germany.—In the case of this country the importance of domestic sources of ore is very great. The calamine deposits of Upper Silesia were among the most noteworthy in the world, whilst blende is the product of several districts, notably of the Hartz. The Upper Silesian deposits yield blende in the deeper workings. The production of zinc ore in Germany for 1913 was 637,308 metric tons, and from this its importance may be gauged.

Greece, with the mines of Laurium and some others, makes a good showing, her output of calcined calamine and blende being, for 1912, 68,497 metric tons.

Italy, with the mineral wealth of the districts of Bergamo and Sardinia, contributed 149,776 tons in 1912. She produces both calamine and blende, and one British company—the English Crown Spelter—operates important mines, and ships the ore for treatment at Swansea. The Sardinian calamine is famous.

Japan is a moderate producer.

Mexico came rapidly forward with her zinc ores, absorbed almost entirely by American smelters, but internal strife and political troubles have gravely retarded the expansion which offered such bright promise of future performance.

Russia is opening out, under the auspices of British capital, several deposits of the complex ore class in the Nerchinsk district of Eastern Siberia, and in the Altai Mountains, Siberia, in the Irtish River district, and her production, not very important now, may well prove a factor to be reckoned with when peaceful conditions permit of the development of her zinc resources on a scale commensurate with their importance. Russian Poland, in the districts bordering Silesia, produces calamine.

Spain, from the provinces of Murcia, Santander and Cordoba, is a contributor to ore supplies, both calamine and blende, her total yield in 1912 being 175,311 metric tons. Practically the whole of that produced was shipped to Belgium, Germany and France for treatment.

Sweden is a notable factor, her principal deposits at Åmmeberg being controlled and worked by the Vieille Montagne. From close investigations made by the author, many of her iron mines yield also no small amounts of blende, and under favourable conditions the potentialities of this country are undoubtedly considerable. Her output in 1913 was 50,036 metric tons, practically the whole being blende.

United States of America.—Alphabetically the last, we turn to this country with premonitory intuition that, in importance at least, it will not be so, and are not disappointed. It is the greatest producer of zinc ores in the world, the output for 1913 being no less than approximately 790,000 English tons — this not including ore exported, or that used in the manufacture of zinc oxide. Both calamine and blende are most extensively worked, and in addition the noted zincite and franklinite deposits. There exist, too, great reserves of the more complex lead-zinc ores, to a considerable extent untouched on account of the abundance of the simpler and purer sources. The chief ore-producing States in their order of importance are Missouri, New Jersey, Colorado, Montana, and Wisconsin, but as no less than nineteen of them figure as producers reference must be restricted to the more important. Of those cited, Missouri, with its famous Joplin district teeming with calamine and blende deposits of singularly docile character, comes easily first. Colorado derives 75 per cent. of its output from the Leadville mines. Montana's contribution comes largely from the celebrated copper district of Butte, and the potentialities are such as to cause confident prediction that this State will prove a serious rival for supremacy. New Jersey deserves special mention, owing to the fact that practically the whole of its ores are won by a single concern, the New Jersey Zinc

Company, from two localities in Sussex County —Franklin Furnace and Stirling Hill. The deposits are unique. Rated on its ore output, the State ranks second, but on the basis of spelter produced fifth only, on account of the enormous quantities consumed in the manufacture of zinc oxide direct from the ore. It is here that zincite, franklinite and willemite attain their high importance as ores, the two latter being often closely associated and separable only by magnetic means devised by Samuel Wetherill, whose name thus became intimately associated with the history and success of the district, as well as on the ground of his application and development of the blowing-up grate for the economic production of zinc oxide direct from the ores.

The State of Virginia yields ores of such character that on distillation they afford zinc of exceptional purity—fine zinc. They are silicate ores, and, as treated by the Bertha Zinc and Mineral Company, with special care pass into commerce as the world-famed "Bertha pure spelter," quoted by Ingalls* as containing 99·981 per cent. of zinc. It is thus nearly chemically pure.

Calamine and blende occur in both lode and bedded deposits, the latter frequently in limestone rocks, but the Broken Hill occurrence of lode type lies in somewhat schistose gneissic rock, and is of great antiquity in the geographical sense. The outline map of the world presented with this paper has been marked with the more important producing districts.

IV.—The Metallurgy of Zinc.

The extraction of zinc from its ores is divided metallurgically into two clearly-defined stages— the preparation for distillation and the distillation itself, the two operations being so distinct that they may be, and often are, carried out for commercial reasons in establishments widely dissociated from one another geographically.

Practically the whole of the world's supply of commercial zinc is obtained by distillation of the ores, in conjunction with carbon as reducing material, in relatively fragile externally-heated fireclay vessels or retorts. Before this can be effected, however, the ores themselves need preliminary treatment to fit them for it, particularly those of the blende class, which require a careful and almost complete desulphurisation. If this be not done, every unit of sulphur remaining behind has the power of retaining and rendering unrecoverable by distillation two units at least of zinc, besides introducing technical troubles in several directions. This rule, while not absolutely applicable to every class of ore, is, in the main, accurate, and with all sulphide ores, however composed, the more perfect the desulphurisation the better may the subsequent distillation be effected.

* "Metallurgy of Zinc," New York, 1903.

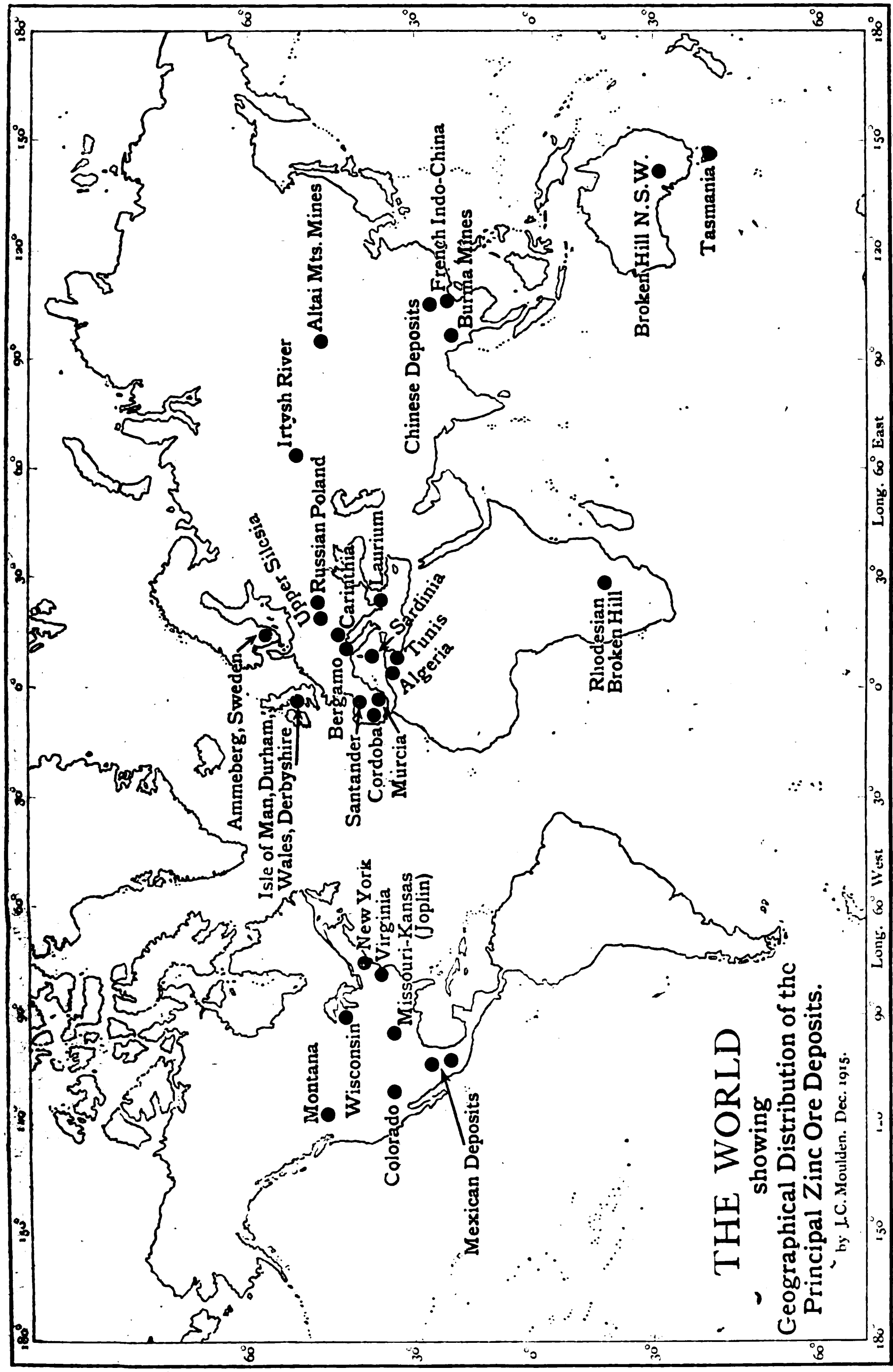
The calamines are calcined for the expulsion of the bulk of the carbon dioxide and combined water. The operation, however, is seldom complete, and as much even as 15 per cent. CO_2 may be left if the ores are very calcareous or magnesian.

Occasionally, indeed, calamine is distilled without such treatment, but few metallurgists will be disposed to accept this course as sound practice. Apart from any other reason, the economy in freightage between mine and smelter is usually sufficient to warrant calcination, this saving being more important where the two are situated widely apart. The operation is extremely simple, and is entirely analogous to the burning of limestone for lime, being carried out in practically similar manner, usually in kilns, in the presence of an excess of air and also of moisture, the two latter points being important for the attainment of good results. The use of kilns is restricted to lump ore, or a mixture of lump and fines, usually in alternating layers, while for calamines consisting wholly of fines it is necessary to use either a reverberatory type of calciner (hand or mechanically operated) or a circular revolving calciner of the well-known Oxland type. The fuel used for kiln work may either be alternated in layers with the ore, or burned on separate fire-grates. If the former, one is rather restricted to the use of charcoal or better-class coal with the corresponding disadvantage of contamination of the calcined material by the contained ash. Calamines containing high proportions of calcium carbonate are the most difficult to calcine with reasonable completeness, and such usually retain a sensible proportion of their original carbon dioxide contents. The chief carbonates associated with calamine, and the approximate temperatures required for expulsion of their CO_2, are as follows*:—

Zinc	carbonate	300° C.
Magnesium	,,	650° C.
Iron	,,	800° C.
Calcium	,,	812° C.

The hydrated zinc minerals need nothing more than simple heating to the dullest perceptible red for their complete dehydration. In

* Ingalls, "Metallurgy of Zinc."


THE WORLD
showing
Geographical Distribution of the
Principal Zinc Ore Deposits.
by J.C. Moulden. Dec. 1915.
Montana
Wisconsin
Colorado
Mexican Deposits
Missouri-Kansas (Joplin)
Virginia
New York
Isle of Man, Durham, Wales, Derbyshire
Ammeberg, Sweden
Upper Silesia
Russian Poland
Irtysh River
Altai Mts. Mines
Santander
Cordoba
Murcia
Bergamo
Carinthia
Laurium
Sardinia
Tunis
Algeria
Rhodesian Broken Hill
Chinese Deposits
French Indo-China
Burma Mines
Broken Hill N.S.W.
Tasmania
Long. 60° West
Long. 60° East
Emery Walker Ltd. sc.

contradistinction to the comparative ease and simplicity which characterise the preliminary treatment of the calamines on the one hand, the blendes, and ores of the sulphide class generally on the other, offer considerable difficulties, and this is particularly true of those which are of complex nature, containing, as they commonly do, substantial amounts of iron, manganese, lead, lime, and sometimes baryta.

The problem calls for the replacement of the original sulphur by oxygen—and that to the greatest possible extent in every case.

Pure zinc blende contains 32·85 per cent. of sulphur, but it is uncommon in practice to find such constituting an ore except in the notable instance of the Joplin blendes. The usual ores may contain a greater or lesser percentage than the figure given according to the presence or absence of iron pyrites, lead, and gangue materials, but 21 per cent. to 30 per cent. would include the limits more usually encountered.

Desulphurisation is usually effected on the crushed ore by roasting in the presence of an excess of air in shelf furnaces of two or more rows. Where the resultant sulphur dioxide fumes are not liable to cause damage or nuisance, and where they are not required for the manufacture of sulphuric acid, the furnaces are of open type, and the fire-gases passing over the ore, together with excess of air, escape to the atmosphere. It is, however, now the practice in most European and many American works to carry on the roasting in conjunction with the manufacture of H_2SO_4, and this for two main reasons—the restriction imposed by legislation in most thickly populated countries upon the discharge of sulphurous gases to the atmosphere, and the value of H_2SO_4 in such localities due to the fact that they are usually also of industrial importance and consumers of the acid, and it therefore pays to utilise the sulphur. It is not uncommon in Europe to find the roasting and manufacture of H_2SO_4 being carried on in one district where the call for the acid is considerable, and the roasted ore distilled in another where conditions as to fuel, clay, and labour are the more favourable. Economic considerations govern, of course, each individual case, and this system has reached its most pronounced development in Belgium and Germany, largely owing to the abundant and cheap facilities for transport afforded by the various canal systems.

Where the manufacture of H_2SO_4 is one of the objectives, certain conditions are imposed upon roasting, the most important of which is the carrying out of the work in muffled furnaces, whereby the fire-gases never come in direct contact with the ore, the fumes from which are led by an independent flue system to the leaden chambers which are most generally used for H_2SO_4 production.

It may be here remarked that the contact system of acid manufacture has found but little application in connection with zinc-ore roasting.

The muffled roaster consists typically of three superimposed muffles on to the hearth of the uppermost of which the ore is charged. It is stirred and moved along by means of tools inserted through a series of working doors, which can be closed by slides, along the side of each muffle and passes to the second muffle through a drop opening at the end of the first hearth. It is moved in the reverse direction along the second hearth, drops to the third, and by a similar process of transference reaches the end of the latter, and is drawn intermittently in desulphurised form. The heating system, which may be arranged for direct coal firing or producer gas, passes under the lowest hearth and away, or under the lowest and then by a reverse turn under the middle hearth thence to the chimney system. There are endless modifications of these furnaces, but the basic type remains the same. They are often built in blocks of four, one fire system serving two roasters, and the conservation of heat being also secured to some extent by the lessening of radiant surfaces. This method of construction also effects an economy in capital cost and a reduction of the material necessary.

The operation of roasting furnaces may be effected manually or mechanically, the tendency in recent years, particularly in the United States, being towards the latter, and a number of such mechanically operated roasters are in use, amongst the most noteworthy being the Hegeler, Brown, Merton, and De Spirlet. On the simpler types of ore they have been most successful, particularly when they are of the non-muffled construction, which permits of simplicity.

The muffle furnace for mechanical operation is another matter, however, and in this form, and for the complex ores particularly, it has not yet reached the development and application which every zinc metallurgist devoutly hopes it may do. Of its economy, if successful, under the special conditions named, there can be no possible doubt.

The basic principles underlying the roasting of zinc ores in general are theoretically simple enough. In the presence of heat and air the

sulphur and oxygen change places according to the following equation—

$$ZnS + 3O = ZnO + SO_2.$$

This reaction is strongly exothermic, the sulphur acting as fuel.

At the same time a certain amount of sulphating takes place in the following way—

$$ZnS + 4O = ZnSO_4.$$

These reactions proceed under normal circumstances with the evolution of sufficient thermal units to render any external application of heat unnecessary. The ore is, once it is heated up, self-roasting to a point roughly corresponding to that attained when the total sulphur contents have been reduced to 8 per cent., the actual figure depending upon furnace construction and composition of ore. Beyond this, the application of heat becomes more and more necessary in order to split up the sulphates, and the process of sulphur expulsion, which began as an exothermic one, ends up by being strongly endothermic, the final finishing temperature in the ore bed lying between 900° and 950° C.

In muffled roasting for the manufacture of H_2SO_4 the roaster gases have necessarily to contain a minimum percentage of SO_2, which may be stated as 5 per cent. by volume. Below this figure the acid-chamber reactions are prejudiced, and if it rises sensibly over 7 per cent. the roasting is retarded. The result is that for conditions satisfactory alike to acid maker and roaster a compromise has to be arrived at which may lie, in average practice, between 5·5 per cent. and 6·5 per cent. SO_2.

However simple theoretically the roasting reactions in the case of the purer zinc blendes may appear to be, the more complex ores give us material for quite different consideration, and it is doubtful whether in the case of many of them the actual steps which lead to the ultimate result are really known.

The ferrous compounds for instance, behave quite differently, according to whether the iron exists primarily as a free iron compound, or as an isomorphous replacement of the zinc, as in certain ferriferous blendes—similarly with manganese.

Lead tends to sulphate in roasting, and as such forms a stable compound difficult to split up save in the presence of free silica and at a high temperature. Calcium and barium when present form also their very stable respective sulphates, which, however, are usually regarded as having a minor prejudicial influence in subsequent distillation.

Copper, in small amounts, introduces no complications.

The net result is that, while certain of the purer ores may, and do, lend themselves to a desulphurisation so complete that no more than from 0·5 per cent. to 0·8 per cent. total sulphur remains, others equally carefully dealt with retain from 2·5 per cent. to 3 per cent., and even more in special cases, particularly those where lime and baryta are present. It is generally conceded that the latter, when constituents of the roasted ore as sulphates, do not exercise the prejudicial effect during distillation that might be expected to result from their reduction to the respective sulphides by carbon in the retort, but the composition of the ore influences, naturally enough, the subsequent thermal reaction in the retort, and each case has therefore to be judged as a separate entity.

Although zinc ores are rarely absolutely free from lead, the trouble introduced by the presence of this metal in substantial amounts prevented to a large extent the smelting of such ores (usually classed as complex) until later years. It is now, however, by no means unusual to find those with 8 and even 10 per cent. of lead being dealt with successfully by ordinary methods, while the writer has had experience in roasting and distilling some thousands of tons containing from 14 to even 20 per cent. lead. The position arrived at is that, with due exercise of care and the selection of appropriate retort materials, the difficulties may be overcome to such a degree as to allow of entirely profitable commercial working. This is of far-reaching importance, as vast additional potential sources for the augmentation of spelter supply have thereby been rendered available, with the prospect of further ones now well within sight.

The presence of lead, usually in the form of sulphide, leads at first to the formation of sulphate, which afterwards becomes partially, although never wholly, split up into lead oxide, sulphur dioxide, and oxygen, which latter no doubt in its turn reacts with the other sulphides of zinc, iron, etc., present. This splitting up, if carried out by main force of thermal units alone and in the absence of silica, is not easy. The really excellent desulphurisation of Broken Hill flotation concentrates—containing say 45 per cent. zinc, and even as much as 10 per cent. lead, which is daily achieved by well-designed muffled roasters—is so remarkable as to be

inexplicable on these latter grounds and merits closer consideration. These concentrates are very low in silica—sometimes, indeed, it is almost absent—and contain their zinc not as true zinc blende, but rather as marmatite, a mineral in which the zinc is partially replaced by isomorphous iron and manganese. During the progress of roasting the iron and manganese form their respective oxides, and from close observations made over a considerable period of time the author puts forward the view that such oxides, under suitable conditions as to temperature and air supply, become strongly catalytic oxidisers. In the presence of these, and of the respective sulphides and sulphates of lead and zinc, complex mass-reactions go on which end in a removal of the sulphur so complete, that at a finishing temperature not exceeding 950° C. the roasted ore of composition above cited may contain as little as 1 per cent. sulphur. The temperature must, in fact, not be allowed to become excessive, otherwise the losses of metals by volatilisation, particularly silver and lead in the form of sulphate, attain quite serious proportions.

The writer has observed also that these results do not seem to follow in the case of ores in which the iron and manganese have no defined chemical association with the zinc, such as mechanical mixtures of blende and pyrites, or blende and rhodonite. Further, the reactions appear to reach their maximum effect in muffled roasters, and are not nearly so noticeable in roasting carried out in furnaces of the "open" type. The thoroughly well-roasted ore of the description referred to has a typical appearance, being of a bluish-black colour, with glistening particles quite different to those of badly roasted material. The colour seems to be due to zinc manganoferrate. Indeed, in muffled roasters under the author's control this compound (artificial franklinite) accumulates on the lowest hearth in impure fibro-columnar aggregates, often in columns of minute octahedral crystals, to such an extent as to render periodic removal by scaling very necessary. It forms, as a rule, in impure masses along with a good deal of lead sulphate, zinc silicate, and lead sulphide finely crystallised. Its formation is indubitable, and an analysis of the separated material gave a result closely approximating to the composition of franklinite, and practically lead and silver free. The analysis referred to is given below, with an example from Dana of the natural mineral for comparison.

Constituent.	Roaster Furnace Product from Australian Concentrate.	Natural Mineral from Stirling Hill, U.S.A. (Dana.)
ZnO . . .	23·25	16·28
Fe_2O_3 . .	70·13	67·38
MnO . . .	4·24	16·38
Insol., Lead, Sulphur, etc.	2·37	—
	99·99	100·04

It has been wittily, if somewhat caustically, put* that—"It is a time-honoured custom to throw bricks at the zinc man. The accusation is that he has borrowed a lime-kiln and a gas-retort and part of a sulphuric-acid plant, hitched them together and spent the last fifty years in regarding with holy veneration the reactions which take place in that retort. The copper man, who thinks of zinc as something with which copper is adulterated to make brass, the iron man who regards it as a sort of paint for corrugated sheets, and the lead man whose opinion as to zinc is not fit for publication, have long felt that when two or three of the minor details of their respective metallurgies were put in order they would take a few days and fix up zinc on a modern basis. But somehow they still seem to have some unsolved problems at home."

It is true that we have to-day in operation methods of extraction which differ little from those used by the veterans Abbé Dony and Johann Ruberg, progress having been achieved rather along the lines of more efficient working and mechanical details, furnaces and fuel consumption, lower costs and higher recoveries, than of any spectacular and radical changes, such as have occurred in the modern metallurgical history of iron, copper and the other common industrial metals. That this is the case is due solely to the chemical and physical limitations of the metal, and in no wise to lack of research, the application of brains and the expenditure of vast capital sums.

The fundamental facts underlying the matter are:—

(1) That zinc oxide is not sensibly reduced by carbon and carbon monoxide below a temperature of 1125° C.†

* *Trans. Amer. Inst. Mining Engineers*, "Metallurgy of Zinc," Jan. 1914.

† Ingalls, "Metallurgy of Zinc and Cadmium."

(2) That at this temperature the reduced metal is in the condition of vapour, not only extraordinarily susceptible to ordinary oxidising influences, such as air and water vapour, but capable even of being oxidised by carbon dioxide.

(3) That the reduction of zinc oxide is a strongly endothermic reaction, necessarily carried out at high temperatures (modern practice calling for 1400° C.) in fragile externally heated fireclay vessels. Thermal efficiency cannot therefore be high.

(4) That the vapour so obtained has to be efficiently condensed to liquid metal, and this in a clay condenser the temperature limits within which must be so narrowly controlled as to lie within points well under the boiling-point and over the melting-point of zinc.

(5) That the operation is not continuous, but has to be carried out on small tonnages in furnaces of strictly limited capacity.

(6) That a loss of metal in the form of vapour, once sustained, is practically impossible to retrieve,

(7) That zinc vapour, for efficient condensation to fluid metal, must of necessity be above a certain density—relatively rich in zinc, thus limiting the profitable distillation of ores to those comparatively rich in the metal.

These are sufficiently formidable reasons to indicate clearly why it has not been found possible to smelt zinc ores in blast or reverberatory furnaces such as are used for iron, lead, and copper. The oxidising influence of carbon dioxide alone on zinc vapour is such that in distillation operations, at the temperatures ordinarily employed in practice, a tenor of 0·25 per cent. CO_2 would be hopelessly inadmissible.

The calcined calamine, roasted blende, or zinc-bearing material containing practically the whole of its metal as oxide—or silicate in the case of the silicate calamines—is mixed with reducing material in the form of coal, coke, or a mixture of both, and heated in fireclay retorts whereby the zinc is reduced to metallic vapour which distils over, and is condensed mostly as fluid metal, and partly in a finely divided pulverulent condition known as zinc dust, blue powder or *poussière*. In South Wales it is customary to use fine anthracite coal as reducing agent, and, when obtainable at a favourable cost, this material is both advantageous and efficient.

A modern distillation furnace consists of a large number of such retorts arranged horizontally in two or three superimposed rows and heated by producer-gas firing. The Belgian furnaces may contain even up to six or eight such rows of small retorts, but modern practice tends to the lesser number. They are arranged usually in two sets, back to back, with an intervening space for the gas and air-ports, the laboratory space in which they are set being a more or less elongated rectangular firebrick chamber with arched roof. The substructure of the furnace is usually arranged for recuperation or regeneration on the Siemens system, whereby the waste heat of the furnace is utilised to heat either the incoming air or gas, or both. The retorts are permanently closed at one end and open at the other, the latter resting on a shelf just outside the lateral furnace wall. To this open end is fitted a fireclay condenser, and to the open end of the condenser is fitted a sheet-iron drum or prolong, which serves to catch as powder the residual zinc not condensed to metal in the condenser, or " pipe " as it is sometimes termed.

Several main systems of distillation practice are in existence, evolved at the main centres of the industry—the Belgian, Silesian, Rhenish, Rhenish-Belgian, and the so-called Welsh-Belgian, which offers nothing novel or distinct as compared with the Belgian proper. They differ mainly in the size and shape of the retort, the number and arrangement of the retorts in the furnace laboratory space, the type of condenser and the system of firing, but the main principle applies to all.

Silesian practice employs the largest retort (or muffle), and Belgian the smallest. Variations between these extremes in working practice and details are so many that a treatise would be necessary to discuss them.

The older furnaces were direct-fired by coal and were very wasteful of fuel. Semi-gas firing on the Bœtius principle followed, and that in time gave way to the Siemens producer with regeneration. The most modern practice is to employ highly efficient steam or air-blown producers with fire furnaces of much higher recuperative or regenerative design.

The adoption of these more efficient thermal methods has resulted in the lowering of the fuel consumption per ton of average ore distilled from two or even three tons to, in favourable circumstances, one ton or rather less, presuming that the fuel consists of a good average coal suitable for gas-producer use.

In the United States a powerful advantage has been turned to account in the form of the immense supplies of natural gas existing in certain localities. The fuel question is so

important a factor in zinc production that these natural gas resources have permitted of the establishment of zinc distilleries in districts which offer otherwise no special advantage, the capital required and the working costs being so lowered thereby as to offset any disability attaching to transport of ore, clays, reducing material and finished product.

The manufacture of retorts and condensers is always carried out at the smelting-works, and forms a most important branch of the art. The retorts vary greatly in cross-section and dimensions, the former being circular, oval, or parallel-sided with semi-circular ends, the main governing factor as to cross-section being that it is not so great as to cause low efficiency by reason of incomplete transmission of thermal units to the central portion of the charge. Circular retorts for this reason seldom exceed 8 in. in internal diameter, while the internal width of the oval and parallel-sided, particularly when used for refractory ores, is seldom over 7 in., and is better when not exceeding 6½ in. The internal dimensions of the retort are—maximum height, $13\frac{9}{16}$ in.; width, $5\frac{11}{16}$ in.; and length, 5 ft. 5½ in. The thickness of the butt or closed end is 2 in., and that of the side walls 1 in.

Remembering that all the thermal units have to pass the poorly conducting walls of the retort, the latter are kept as thin as compatible with strength and impermeability. They seldom vary in ordinary practice up or down of 1 in. in thickness, but the bottom may be 2 in. or even 2½ in. to resist the corrosion of slag and matter formed in distillation.

The requirements for a good retort are refractoriness, strength, density, and impermeability to zinc vapour, freedom from cracking, and maximum resistance to the cumulative corrosive effect of the impurities in the charge. The clays therefore utilised in the manufacture must be of special nature adapted to meet these conditions, which are best covered by a mixture composed of burnt clay, or chamotte, and sufficient raw clay to act as an efficient binding agent.

In modern practice finely-ground coke is often used to replace part of the chamotte, as it assists in retaining the shape of the retort under great heat and gives density and impermeability.

A typical retort mixture would consist of:—

Crushed burnt clay (chamotte) . .	50 parts
Raw clay	40 ,,
Finely ground coke	10 ,,

The chamotte is crushed to pass a screen of eight holes to the linear inch, and the raw clay and coke as finely as possible. The mixture is damped so as to contain 15 per cent. moisture, passed through a pug-mill and allowed to "mature"—the maturation developing plasticity possibly owing to the formation of "gels," or films of gelatinous silica, on the particles composing the raw clay. After maturation, the duration of which may be a matter of days or weeks, the mixture is repugged and is ready for retort manufacture.

Retorts were originally manufactured by hand, but are in modern practice almost exclusively machine-made in a hydraulic press. The mixture is either pressed or stamped into the form of a cylindrical ballot which is pressed or squirted in a hydraulic press in very similar manner to that in which earthenware drain-pipes are made.

Maturation is dispensed with by certain works and the freshly pugged mixture pressed forthwith. Variations in composition of mixture to secure the desiderata already enunciated are very common, and some retort mixtures may contain four or five different clays to obtain the sought-for condition. A tabular list of eight typically suitable clays and their analyses is appended.

The green retorts are stood upright in rows in chambers to dry, the process being accelerated by artificial warmth conveyed by warm air or steam-pipes towards the end of the drying. The manufactured retort may contain 12 to 14 per cent. moisture, and this at the end of three months is reduced to 1 per cent. or under, when it is ready for distillery use. The final drying chamber temperature may run from 120° to 130° F.

The condensers are of various forms according to the retort capacity, type of furnace and system of distillation. They may be plain clay cones, conical-bellied to act as a metal receptacle, or D-shaped. Made of common clay mixtures by either hand or machine, they need little of the meticulous care necessary in retort manufacture, as they are not called upon to resist the same high temperatures or other destructive influences. After careful drying, with or without baking, and sometimes a coat of lime-wash, they are ready for use.

The retorts before being used for replacements in the distilling furnace are tempered by being gradually heated in a tempering oven or stove, until they attain a full red. In this condition they are transferred to the furnace and luted in position.

ANALYSES OF CLAYS SUITABLE FOR SPELTER RETORT MANUFACTURE.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Silica . . .	51·15	45·50	55·73	45·01	49·50	45·10	53·00	49·18
Alumina . .	31·97	37·29	42·69	36.02	34·46	36·16	41·76	31·70
Lime . . .	·73	·27	·28	·10	·80	·29	·33	·98
Magnesia . .	·22	·24	·23	·24	·62	·16	·15	·58
Ferric Oxide .	2·37	1·51	·37	2·03	2·39	1·75	2·84	·98
Alkalies, K_2O N_2O . .	1·00	·66	·50	·31	..	..	·86	2·82
Titanium Oxide	..	..	..	..	..	1·33	..	2·77
Loss on Ignition	12·61	14·56	..	16·64	12·86	15·21	1·07	10·87
	100·05	100·33	99·80	100·35	100·63	100·00	100·01	99·88
Refractoriness, Seger Cone No. and Degrees C.	35=1770° C.					33=1730° C.	33=1730° C.	34=1750° C.

I. Saarau blue clay (raw).
II. Typical Briesener clay (raw).
III. Neurode shale (burned) for chamotte. Ingalls' "Metallurgy of Zinc."
IV. Typical Stourbridge clay, suitable for retorts. Private analysis.
V. St. Louis, Mo., U.S.A. Average composition. Ingalls' "Metallurgy of Zinc."
VI. Raw clay of lean type (Mark Bjüf F). Höganäs, Sweden. Analysis by Höganäs-Billesholms Aktiebolag. Fusing-point Seger Cone 33=1730° C.
VII. Swedish burnt shale for chamotte.
Analyses I., II., and III., by S. J. Tweedy, Central Zinc Co., 1912.
VIII. Is an English clay of fluviatile origin, very plastic and dense when burned. The alkalies and titanic oxide are unusually high for so refractory a clay.

The process of distillation is not a continuous one, but consists in a well-defined cycle of operations repeated every twenty-four hours.

The roasted ore or zinciferous material, always in oxidised form, is mixed with from 45 to 60 per cent. of its weight of reducing material—coke, coal, or anthracite. This mixing, formerly done by hand, is in all modern plants performed by mechanical means.

The proportion of reducing material requisite is enormously in excess of theoretical requirements—in point of fact, from four to five times the latter or even more.

The retorts emptied of their exhausted charge are cleaned, patched, or changed if necessary, and the mixed charge, slightly damped, charged in by hand-scoops—either thrown in, where removable condensers are used, or through the condenser in the Silesian fixed-condenser type. Condensers are luted up, cracks, etc., and leakages stopped with clay, and distillation proper begins. The moisture and volatile matters are first driven off, followed by the reduction of the iron, and this again by the reduction of the zinc. The resultant carbon monoxide at the condenser mouth is ignited, and burns with its characteristic flame tinged more and more by the bluish-green of zinc. The sheet-iron drums or prolongs are then fitted to the end of the condensers, and the temperature gradually raised over a period of hours until in about from twelve to fourteen hours from the inception of distillation it attains its maximum, and is maintained until the CO flames and the sinking of the retort charge indicate that the operation is practically complete. The oncoming shift of furnace hands then take charge, tap the condensers and prolongs for their metal and

zinc powder respectively, draw the spent residues, change the retorts and recharge. So the process goes on, one charge per twenty-four hours being worked off.

It must here be observed that the metal may be tapped three or four times during distillation into hand ladles, or once only into a mechanical ladle runinng along the furnace front, also that charging and discharging of retorts may be accomplished by mechanical means. The latter is, as yet, in its infancy, and the majority of works still employ manual workers for the purpose.

A typical time-table for the twenty-four hour cycle would be: 7 a.m. to 12.30 p.m.—Metal tapped and cast, residues drawn, retorts changed, furnace charged and luted up. 12.30 to 1 p.m.—Cleaning up, luting leaks, etc. 1 p.m. to 2 p.m.—Charge heating up, furnace house cleaned up, etc., and left for workmen who attend to furnace over distillation period. 2 p.m. to 7 a.m.—Distillation period. Prolongs attached to condensers as soon as zinc flame appears.

This cycle of operations has been illustrated graphically, and in greater detail, by means of a clock-chart, divided as to the one half from twelve (noon) to midnight and the other from midnight to twelve (noon). It will naturally be understood that this chart is an idealised view of the operations. Variations in practice and circumstances would cause variations in the time-table.

The progress of distillation can be observed and the charge in each retort watched through the open condenser. The metal is poured into cast-iron ingot moulds and forms, plates or cakes, rectangular in form, the dimensions of which are about 17½ in. by 8½ in. by 2½ in., each cake weighing from 45 to 50 lb.

The zinc powder from the prolongs is sifted through a sieve of seventy meshes per linear inch, and sold as such after packing in drums or barrels.

In its best form it contains from 86 to 92 per cent. of zinc as metallic zinc. The formation of some powder is inseparable from distillation, but the proportion varies according to the manner in which the work is carried out, and may also be deliberately controlled by the use of a haloid salt, such as common salt, placed preferably at the mouth of the retort or even in the condenser. In this position it fulfils its object perfectly, without the drawback of influencing the lead and silver contents of the charge, as it does if mixed with the latter in the case where complex ores are under treatment. This method is the subject of a patent by H. W. Webster and the author, and has passed into practical use with entirely successful results.*

The exhausted residues, as drawn from the distillery retorts, drop into cellars or pockets, and in the case of clean zinc ores are thrown away. When, however, complex ores with lead and silver are under treatment they are usually concentrated by simple water-concentration in jigs or on tables, and the enriched material passed to the lead smelter.

The old retorts are thrown to the waste heap, but the condensers are chipped for the crusts of metal and oxide, which are returned to the retort charge. After so chipping, there is usually sufficient adherent oxide to render crushing and concentration profitable, the concentrates with 60 per cent. zinc and upwards being also redistilled. The condenser scrapings, oxide, and dross from the metal ladle are all recharged to the distillers in addition, and the metal resulting from the treatment of these bye-products amounts to a very sensible proportion of the eventual total extracted from the ore.

The spelter as produced by distillation varies greatly in quality according in no small measure to the composition of the ore from which it is produced. The American willemite ores yield a very pure metal, but all spelter produced from leady ores contains lead. By simple liquation the latter may be reduced to 1 per cent., or rather under, but no further, and for purer metal a redistillation must be resorted to. The metal obtained direct at one operation from the ore is often termed "virgin spelter," and a typical composition of such is appended in the form of an analysis, specially made for the purpose of this paper, of a good English spelter produced from Broken Hill ore by the Central Zinc Company, Limited, at Seaton Carew. It is:—

Zinc (by difference)	98·642
Lead	1·205
Iron	·060
Cadmium	·089
Copper	·004
	100·000

Some commercial spelters contain 2 or 3 per cent. of lead, and even pass into the market in this form; but it is usual to treat the metal when so impure in large liquating furnaces holding twenty or thirty ton charges. The bath is drossed and kept molten at as low a temperature as possible. The bulk of the lead separates by gravity and accumulates at the bottom of

* British Patent No. 26,788, 1910.

the bath, while the better grade of spelter is ladled from the top and cast. It may be taken that, with the greatest care, large bulk of metal, and long time-factor, the lead cannot thus be reduced below 0·8 per cent., and the general practice is nearer 1 per cent.

The simple fact is that lead and zinc do not alloy at all, but lead is soluble in molten zinc in degree varying with the temperature, much as lead chloride is soluble in water. At a temperature just above the melting-point of zinc (the latter determining the ability to cast the metal) it is soluble to an extent represented by about 0·8 per cent. Metallographic research by the author, on polished and etched sections of spelter, indicates beyond doubt that, at the freezing-point of zinc, the still molten lead is rejected and forms minute globules, occupying often the cleavage cracks caused by the contraction of the highly crystalline zinc. This is further confirmed by microscopic examination of the residues left after dissolving commercial spelters containing various percentages of lead, in very dilute sulphuric acid, when the minute lead spheres are very apparent.

This question of lead in spelter is of the utmost importance, for in many cases the sole practical difference between ordinary commercial spelter and the much more valuable fine-zinc is represented by the lead. Any cheap and readily applicable method for its elimination (short of redistillation) would find both world-wide application and substantial remuneration. Never has the need been more pressing, so far as our country is concerned, than during the present times with the insistent demands for munitions of war.

Lead separated by liquation from spelter still contains 2 per cent. or more of zinc, but owing to the great affinity for silver and gold that the latter has it may be counted upon as being absolutely free of the precious metals. The zinc is readily removed from the lead by a current of dry steam or by scorification, and this fact presents a ready method for the preparation of absolutely gold and silver free lead, which is often a desideratum where the assaying of the latter metals or their ores is concerned.

Whilst practically the whole of the spelter of commerce is produced substantially in the manner described, great efforts have been made, and large sums of money spent, in the endeavour to simplify, expedite, and cheapen extraction, and in particular to render the process continuous.

The electrolysis of zinc solutions (both sulphate and chloride), reduction by blast-furnace methods, and the electrothermic method of continuous distillation, whereby the distillation is carried on by thermal units produced within the reducing-vessel or furnace itself, have all been devised and exploited.

Electrolysis finds some very limited application, blast-furnace methods for direct metal production have failed entirely, and the electrothermic method, or electrical smelting, offers probably the most promise. It is, however, necessarily limited to such localities as can offer heavy electric currents at very low cost. For this reason its exploitation has been confined wholly to countries where electric currents can be most cheaply produced in large quantities by water-power. The most notable and important works are located in Norway and Sweden, in the latter of which there is at Trollhättan a works equipped for 18,000 h.p. These are to-day in operation, and have produced many thousands of tons of zinc by electrothermic distillation. The author would express the opinion that, given favourable primary conditions and the inevitable improvement to be brought about by experience, this method will in the future substantially influence the production of zinc.

[The concluding portion of the paper, with the discussion, will be published next week.]

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Progress in Dye-Making.—Unavoidable delays in structural work are now holding back the enlargement of the supply of British-made dyewares. In particular, fuming sulphuric acid is scarce—at all events for other than military purposes—and some time must elapse before the supply can be appreciably increased. After the war this re-agent promises to be almost embarrassingly plentiful, and it is altogether probable that the chemical plants now being erected for the manufacture of explosives will enable colours to be produced at cheap rates later. Although the cost of erection is perhaps twice the normal, it should not be impossible to write off the excess out of current profits. Pending the completion of new colour works in this country, imports from Switzerland afford some relief to consumers, and it appears that there remain certain stocks of German-made dyewares to be had at exorbitant prices from China. It is said upon good authority that there is still not a single coal-tar dyestuff made in this country suitable for a calico printer to use, and the needs of that industry can be reckoned by the thousand tons. Nearly all textile activities are circumscribed by the shortage of dyestuffs and the progress

of preparations for manufacture is being most keenly followed. It is fairly certain that large sums of capital could still be found for colour manufacturing, although perhaps not without some pledge of assistance from the Government. Dr. Alfred Rée, the new president of the Society of Dyers and Colourists, whose past experience in the production of high-class dyestuffs lends weight to his opinions, sees no reason why with reasonable assistance the colour industry should not be established on really successful lines. Like the late Mr. Ivan Levinstein, whose recent death is to be regretted, Dr. Rée lays great stress on the need for reforming the British patent laws. Indeed there is no British colour manufacturer who has had a chance to remain oblivious of the restrictions laid upon him by the adroit use made of our laws by strangers.

Lordly Velvets.—Manufacturers of goods at pence a yard or shillings a yard are little given to thoughts of the aristocratic cloths that are manufactured to sell at pounds a yard. It is more or less open knowledge that such goods are made, notably in Lyons, upon looms of which the output is measured not in pieces per week, but inches per day. Business in them has not attained to its full height in England, where the opportunities have been even deplorably neglected. Mr. Frank Warner has satisfied himself that there is room for expansion upwards, and his patient efforts in the production of fabrics worth large sums of money have led to the gradual perfecting of figured velvets of a unique richness, suitable for upholstery. A description which reduces the articles to the barest technical terms that will describe their nature does poor justice to them. The element of novelty in the fabrics consists in the weaving of a pile in three separate heights, and the difficulties of this achievement have been triumphantly surmounted by the inventor. However, neither the structure nor the composition of the finest silk is enough in itself to justify the high values set upon the cloths by connoisseurs. Their merits require to be taken as a whole in the light of the facts that the designs and colourings are perfect expressions of a classical taste, and that the cloths will appreciate rather than depreciate with the passage of time. England has something solid to add to the treasure of textile art, and the pity is that so few other manufacturers than Messrs. Warner & Sons are concerning themselves to make fabrics for the admiration of posterity.

New Relays of Labour.—Textile operatives as a whole are of a stationary disposition, ready to remain in the locality in which their lives have been cast, and to resist the temptation of higher wages which might be obtained by a removal of only a few miles. They are perhaps even more apt to remove to long distances, such as America, than to go shorter ones. The mills are fed pretty consistently with labour drawn from the immediate vicinity, and only in exceptional times is there an appreciable influx from the outside; in which case the importation of families from the rural parts of the country has been known. There have in times of stress also been transfers of widows and their daughters from large cities in which female labour is poorly remunerated. The introduction of young women by the hundred is something new. They are brought through the agency of the Labour Exchanges to towns in which hostels have been provided for their reception, and they come as temporary workers replacing men who have joined the Forces. The experiments are of interest because they bring new ideas into play, and it is probable enough that permanent marks will be left by them. Work that has been traditionally treated as a man's job, although it is far from calling out all the faculties of a man, is being learnt by these women; and where the results prove favourable it is scarcely credible that the employments can be regarded in quite the same light as before. It is the way of these transmigrations to be lost to sight, but some movements of the past are at least recorded. Numerous Norwich weavers removed to Bradford when East Anglian trade failed them, and Coventry at one period supplied drafts to Lancashire. Kidderminster has furnished carpet-weavers to other centres fairly continuously for a century or more, and the centrifugal forces in Scotland have dispersed Scottish workers widely over this and other countries. A hundred years ago, in circumstances resembling those of to-day, no doubt the workhouses would have been emptied into the mills by the aid of the forgotten "poor waggons."

River Water.—The rivers in the densely populated industrial localities have not been improving in appearance during the war, although the inkyness that meets the eye is not the worst of their offence. The scarcity of common sulphuric acid has interfered with some of the regular processes of purification to which textile trade effluents are subjected, but this absence of acid is being repaired by the general employment of nitre cake, removed from the new nitric acid stills. The rivers have suffered from acidity proceeding from the washing of picric acid and trinitrotoluene, and their water has thus been treacherous both in dyeing and in steam-raising. The usual balance of conflicting impurities has been upset, and dyers have not been able to count upon the customarily strict neutrality of rivers that have received the sewage of several large towns and of hundreds of industrial works. Near the head of a stream the apparently clear and pure water is liable to vary in quality by the liberation of minerals and acids from the soil in the event of heavy rains. Lower down, after extensive fouling and certain opportunities of fermentation, the water acquires a more consistent character, and it is rather odd to realise that there are industrial users who greatly prefer water that has been freely blended to that which is seemingly fair and bright.

CORRESPONDENCE.

ORGANISATION OF SCIENTIFIC RESEARCH.

I have read with great interest the proposed plan for the Organisation of Scientific Research in England. It seems to me that the chief and requisite necessity has not been referred to.

It is generally conceded that the German organisation has produced excellent results. I think this was possible because of the co-ordinated support the chemist receives in Germany from the working-man right up to the head of the business. The chemist in Germany is respected, because it is recognised that his work is necessary for the proper extension of business.

By reason of the enforced conscription in Germany the people are taught obedience, and, as a rule, have good health, and you know how important those two qualities are.

The Government takes a paternalistic interest in seeing that the German enterprises earn enough money to permit them to go ahead along proper lines. At the same time, the Government insists that the workers are looked after. The people in Germany, as a whole, agree with the paternalistic ideas represented by their Government, and therefore, the German organisation and German capacity for production, which must be admired, are the results of the desires of the majority of the German people.

The thoughts and ideals of the majority of the people are usually crystallised and appear in the character of their civic and commercial organisations. Militarism, therefore, may be but a part and not the cause, although some people think that everything good in German organisation is the result of their military system.

The liberty of England, as well as that of America, is often abused. The mass of citizens do not appear to understand how necessary it is to limit one's personal desires for the benefit of all. This is better understood in Germany. I believe, therefore, that the whole economic system in England must be changed before an organisation can be built up on the lines of German organisation.

A. ALEXANDER.

New York.

In connection with Professor Fleming's most interesting paper, may I call attention to two important points which received inadequate attention in the discussion :—

(1) The desirability of each technical and engineering society "boiling down" previous results into such a form that any man (member or not) can at once obtain information which will enable him to avoid retracing old ground. In this connection each society should produce each year a very detailed report on progress in all subjects that concern it, something on the lines of the "Britannica Year-Book," but better than that.

(2) The advantage of deciding (*a*) what industries are necessary for independence, and are therefore to be practised as far as possible by each and every nation; and (*b*) what industries may be locally specialised so as to produce the highest economy and efficiency in international trading.

HERBERT CHATLEY, D.Sc.(Eng.), Lond.

NEXT STEPS IN EMPIRE PARTNERSHIP.

In the discussion on Mr. Hurd's paper one speaker is reported on page 428: "The reason South Australian copper had not been purchased was that the Home Government had been able to procure plenty from America. That betrayed a want of outlook in the official world which would, if continued, kill the possibilities of the Empire as Imperialists would like to see them develop."

Now, is it not a fact in history that the importation of Australian lead helped to "kill the possibilities" of English lead-mining?

Twyford, Berkshire. WM. H. MASSEY.

ROUTE-MARCHING BY THE STARS.

It is very flattering to Colonials to be told by Colonel Tilney, in his paper* about the use of stars for finding the way, that they have a special aptitude for navigation at night without the aid of a compass, using the stars as guides. Personally, I know of no Colonial who at any time guides himself by the use of the stars. I speak not only of New Zealand and Australia but also of South Africa. In country districts people move about very little after sundown, and then only over and by well-known tracks. It is quite a common thing for Colonials when travelling in unfrequented country to lose themselves in daytime, let alone at night. Last month the papers reported two search parties out attempting to find "bushed" men. I never heard of the Bantu people of South Africa using the stars in navigation. In the districts known to them they make good guides, but they seem to use that peculiar sense known as "locality," of which we used to hear so much from the phrenologists of earlier days. Leaving aside the few educated people in New Zealand, Australia, and South Africa, I do not think that one in twenty ordinary people could distinguish or name one star in the whole heavens. Here in New Zealand comparatively few know even the Southern Cross.

I feel sure you will pardon my little criticism of Colonel Tilney's statements respecting the Colonials' use of the stars. JOHN A. R. GRAY.

Auckland, N.Z.

* Read December 8th, 1915.

GENERAL NOTE.

ENCOURAGEMENT OF FLAX AND HEMP-GROWING IN FRANCE.—To encourage the cultivation of flax and hemp in France a premium, at the rate of 60 francs per hectare (nearly £1 per English acre) has been offered to growers of these crops by the Government. This is the maximum yet granted, as authorised by the law of 1910. According to the statistics published by the Minister of Agriculture, the area under flax in 1915 amounted to 9,685 hectares (24,422 English acres) in the thirty-seven departments where this plant is grown, and 10,185 hectares (25,157 acres) in forty departments for hemp. The average areas under these crops annually during the ten years previous to the war, viz.; from 1904 to 1913, were: flax, 26,370 hectares (65,134 acres), hemp, 16,200 hectares (40,014 acres).

MEETINGS OF THE SOCIETY.

(The times given are Parliamentary, not true.)

INDIAN SECTION.

Thursday and Friday afternoons, at 4.30 p.m.:—

JUNE 1.—PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India." THE RIGHT HON. LORD ISLINGTON, P.C., G.C.M.G., D.S.O., Under-Secretary of State for India, will preside.

JUNE 23 (Friday).—SARDAR DALJIT SINGH, C.S.I., "The Sikhs."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 29...Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Annual General Meeting.

TUESDAY, MAY 30...Royal Institution, Albemarle-street, W., 3 p.m. Dr. T. M. Lowry, "Optical Research and Chemical Progress." (Lecture I.)

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Mr. F. S. Marvin, "World Relations and World Organisation—Culture, Ethics and Religion."

THURSDAY, JUNE 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Professor W. R. Dunstan, "The Work of the Imperial Institute for India."

London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m.

Linnean Society, Burlington House, W., 5 p.m.

Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. R. Seligman and P. Williams, "Hydrates of aluminium nitrate." 2. Messrs. K. C. Mukherjee and E. R. Watson, "Dyes derived from phenanthraquinone." 3. Mr. E. Newbery, "Overvoltage tables. Part I.—Cathodic overvoltages."

Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander Mackenzie, "Chamber Music and its Revival in England." (Lecture II.)

FRIDAY, JUNE 2...Royal Institution, Albemarle-street, W., 5.30 p.m. Lieutenant P. H. Loyson, "La France dans l'Histoire comme Champion du Droit."

SATURDAY, JUNE 3...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. G. Frazer, "Folk-Lore in the Old Testament." (Lecture I.)

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FRIDAY, JUNE 2, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

INDIAN SECTION.

Thursday afternoon, June 1st, 4.30 p.m.; THE RIGHT HON. LORD ISLINGTON, P.C., G.C.M.G., D.S.O., Under-Secretary of State for India, in the chair. A paper on "The Work of the Imperial Institute for India" was read by PROFESSOR WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S., Director of the Imperial Institute.

The paper and discussion will be published in subsequent numbers of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

TWENTY-FIRST ORDINARY MEETING.

PETER LE NEVE FOSTER PRIZE ESSAY.

ZINC, ITS PRODUCTION AND INDUSTRIAL APPLICATIONS.

By J. C. MOULDEN, A.R.S.M., M.Inst.M.M., Member, Australasian and American Institutions of Mining Engineers.

IV.—THE METALLURGY OF ZINC (*continued*).

Fine-Zinc.—The highest grades of zinc have to be produced by either the employment of special materials and distillation methods, by electrolysis, or by the redistillation of commercial spelter. The reduction of very pure ores (or zinc oxide) by ordinary distillation is carried out largely in America by the New Jersey Zinc Company, and in Europe by the Vieille Montagne. Electrolysis finds a limited application, and there are plants in England for the purpose; their output is, however, on a limited scale.

The redistillation of ordinary spelter is responsible for considerable quantities, and as carried out in the electric arc furnace in Norway and Sweden is particularly successful. Redistillation is really a fractional distillation of spelter, whereby the more readily volatile zinc is distilled and condensed, leaving the lead and iron behind in the distillation vessel.

Fine-zinc may be in general, if somewhat arbitrary, terms described as containing less than 0·1 per cent. lead and 0·1 per cent. iron; the balance is not usually wholly zinc, for cadmium is often present in quite sensible amount, but the total removal of this constituent by fractionation is quite impossible commercially, and in the quantities in which it is usually present it exercises no known detrimental influence for the purpose to which fine-zinc is customarily applied; these purposes include fine brass for spinning and drawing, fine-zinc alloys of all descriptions, and generally all cases where the introduction of lead or iron in such small quantities as occur in commercial spelter would be inadmissible. Specimens of fine-zinc with 99·95 per cent. zinc, and the purest possible metal produced by the electrolysis of zinc sulphate solution, are submitted.

The points of interest germane to the metallurgy of zinc are so numerous that, short of a treatise, it would be quite impossible to refer to most of them.

Wide variations in ores, methods, and practice create almost local "metallurgies" of their own, the basic principles remaining, however, unaltered.

Chinese practice is, for instance, a closed book to us as yet; notwithstanding this, quite a substantial quantity of Chinese zinc of really good quality has found its way to England since the war.

Such matters as thermal efficiency and consumption of fuel per ton of ore, the percentage extraction of zinc, working costs and capital cost of works' installation, cannot profitably be entered upon unless accompanied by such a wealth of explanatory detail as to remove them quite beyond the sphere of this paper. In very broad terms, however, it may be stated that the extraction of the zinc under modern European methods varies between 80 and 90 per cent., calculated upon the roasted ore contents, with a fuel consumption of from 1¼ to 2 tons of coal

per ton of raw ore. The extraction, under European practice, is very generally referred to in terms of the percentage calculated upon roasted ore contents, for the reason that the roasting is often carried out in establishments totally dissociated from the distilleries, and the latter, in receiving roasted ore for distillation, have quite often no exact knowledge of the original zinc tenor of the raw sulphide ore.

Among the specimens exhibited is a portion of the wall of a used retort showing the formation of zinc aluminate (zinc spinel) of a deep-blue colour. It is a definite chemical compound ($ZnAl_2O_4$) corresponding with the natural mineral gahnite, and is due to the reaction between the aluminous retort and the zinc. It at one time constituted quite a material source of loss in zinc distillation, but with the modern hydraulically-pressed retort of dense structure it has almost disappeared as a factor of any moment. Its formation in the case of very aluminous calamines is of serious import in lowering the commercially practicable zinc recovery from ores so constituted.

Of great metallurgical interest is another hand-specimen illustrating the complexity of reaction which may take place under certain conditions. It is the result of smelting in the electric furnace a zinc ore containing lead, copper and silver. It contains copper, zinc and lead, all in the metallic condition, copper matte with moss-copper and slag; more interesting still, it illustrates very clearly the direct production of brass from the copper-zinc ore.

Do we but pause to consider and appraise at their proper value the inherent difficulties attached to the art, we may fairly console ourselves with the reflection that the modern metallurgy of zinc, much as it leaves to be desired, is not substantially inferior in its methods and practice to that of the other metals in common daily use.

Subsequent to the writing of this essay there has appeared the digest of a paper on "The Economics of Zinc Metallurgy" by W. R. Ingalls,* written with all the clarity and directness of that well-known authority on the question. Its perusal may be safely recommended as an exposition of the sane truth, and as an antidote to much of the misleading nonsense to which we have been treated during the last twelve months.

Of recent years two potent factors have operated in the direction of rendering available much increased ore supplies from raw materials which would be *per se* too poor, or otherwise unsuitable, for the extraction of their zinc contents. These factors, whilst not, strictly speaking, of metallurgical nature, have nevertheless had such influence upon the metallurgy of the metal, and contributed so much towards the increase in the world's production, that they may quite properly be included here.

The first of these was the Wilfley concentrating table, which opened up new avenues for the effective recovery of rich zinc concentrates from mixed and low-grade crude ores, working along the ordinary lines of water concentration.

The second was the introduction of flotation concentration, whereby extraordinarily effective work can be done in the production of rich zinc concentrates from crude ore absolutely untreatable commercially by any other known method. It is applicable to the finest slime or pulp, and as it does not depend for its success upon questions of relative specific gravity, is adaptable with peculiarly profitable results to those cases in which the desideratum is the production of a high-grade concentrate from an ore containing as gangue other minerals—*e.g.*, garnet, rhodonite, or baryta—so close to blende in specific gravity as to be inseparable by ordinary water concentration.

It really found its first extensive application in the mills of the Broken Hill (N.S.W.) mines, and one may safely say that without it the ores of this district could never have attained the influence they now wield in the domain of zinc.

Its latest development has been in the United States, where, curiously enough, its importance received but tardy recognition. The Anaconda Company, best known as a copper producer, has now adopted flotation as the means for producing great quantities of zinc concentrates, which will be subjected to sulphate roasting, lixiviation and electrolysis for the production, it is stated, of no less than 35,000 tons of fine-zinc per annum. It is, therefore, a highly important venture.

Electrolytic zinc is no new thing, and its past record may be fairly summed up as a series of failures—due, be it observed, not to any inherent impossibility of the method, but rather to adverse circumstances, unsuitable ores and the like. There are, however, special circumstances connected with the case which render success very probable. Into these we cannot enter here, but those interested will find a clear statement of them in a recent memoir by

* *Chemical Trade Journal*, Dec. 11th, 1915. Digest of a paper by W. R. Ingalls, International Engineering Congress, San Francisco.

Ingalls,* who discusses not only this particular instance, but the prospects generally of electrolytic zinc in relation to the usually accepted methods of production.

V.—The Uses of Zinc and its Compounds.

Zinc has become so much a part of our modern life that there are few of us who do not daily handle it in some form or another. Every particle of brass or German silver contains its proportion, and the bronze coinage of the Realm is a triple alloy consisting of 95 parts of copper, 4 of tin and one of zinc.

Up to about the middle of the nineteenth century the industrial uses for zinc were confined substantially to the manufacture of alloys and to rolled sheets, largely used for roofing. With the spread of the so-called galvanising, whereby sheets of iron are dipped in molten zinc and receive a thin coating, a new avenue for its employment was opened up, and this industry is to-day the greatest consumer of the metal.

Alloys.—The manufacture of alloys constitutes certainly the most varied and interesting use of zinc, although in importance of actual tonnage of metal consumed it comes at least second to galvanising.

Zinc alloys with copper in all proportions to form brass. The ordinary brasses contain from 27 to 45 per cent. of zinc, with from 73 to 55 per cent. of copper, the colour and characteristics varying with the relative proportions of each. For the commoner brasses, particularly those for casting and turning, a small proportion of lead, such as is contained in commercial spelter, is not only admissible but even desirable; but for the finer grades, and those intended for spinning and drawing, it exercises a most detrimental effect by causing cracks and fissures. In such cases, therefore, a specially pure metal has to be used containing 99·8 per cent. of zinc as a minimum, with 0·1 per cent. of lead and 0·1 per cent. of iron as maxima.

These fine brasses are essential for the production of cartridge-cases, alike for rifle, machine-gun and the lighter types of artillery.

For turning, on the contrary, the alloy should contain a well-marked proportion of lead, together with relatively high zinc and low copper. This leaded alloy is often called "clock brass," the best all-round working properties being secured when the proportion of lead rises to from 2 to 2½ per cent. in an alloy in which the proportion of copper is as 60 to 40 of zinc. This turns freely and cleanly and, with due care, allows of rolling and drawing to a substantial extent.

The subject has been investigated by Sperry* with much care.

The greater the proportion of copper the greater the difficulty in machining, and for shell-brass the ratio may fall as low as 55 copper to 45 of zinc.

Muntz metal is a brass, formerly much used for the sheathing of wooden ships, being much cheaper than copper and not so liable to foul. The inventor prescribed 60 of copper to 40 of zinc.

Cartridge brass, subjected as it is to the severest of treatment, requires the use of both copper and zinc, as pure as possible, with commonly 70 of the former to 30 of the latter.

Brasses with a small content of iron ranging from 1·5 to 4·5 per cent., with 55 to 60 of copper, and 38 to 41 of zinc, give alloys which, when hammered or rolled, possess very great tensile strength, Sterro and Aichs metals being representatives of the class.

The colour of the copper-zinc series varies from the red of pure copper at one end of the scale, through infinite gradations of reddish-yellow, full and pale yellow to the bluish-white of zinc at the other end.

The alloys very high in copper and low in zinc have found their greatest use in decorative work for such articles as buttons, imitation gold jewellery, and the like. Tombac, Mannheim gold, Oreide, pinchbeck, mosaic gold, Dutch metal and some others under equally fanciful names, although of practically similar composition, are those most nearly approaching gold in colour and characteristics. They have for long been used, either alone in the cheapest class of jewellery, or as a basis for the deposition of gold by plating, owing to the fact that their colour allows of a real golden effect being obtained with the thinnest possible film of the precious metal.

In the latter part of the eighteenth and early half of the nineteenth centuries some really beautiful and artistic work was executed in pinchbeck—work exhibiting the craftsman at his best. To what base depths the alloy has sunk in our times is glaringly and garishly proclaimed to all who care to take a stroll from St. Paul's to Trafalgar Square and observe. A

* W. R. Ingalls, "Electrolytic Zinc," *Engineering and Mining Journal*, March 4th, 1916.

* Sperry, "The influence of Lead on rolled and drawn Brass," *Trans. Amer. Inst. Mining Engineers*, Vol. XXVII. p. 485 *et seq.*

typical pinchbeck would consist of 83·5 parts of copper and 16·5 of zinc.

German silver, so-called, is a triple alloy of copper, nickel and zinc; the composition is very variable and is adjusted to the quality desired, remembering always that the common grades contain the least of the most expensive constituent—nickel, which may graduate from the 34 per cent. possessed by the finest to the 7 per cent., or less, in the commonest. A typical fair quality would be composed of copper 60, nickel 20, and zinc 20. The alloy is excellently adapted as a base for the reception of silver-plating, and its use in Continental coinage is familiar to most.

It is interesting to note that a variety of German silver has long been known in China, whence it was exported to Europe in considerable quantities under the name of "pakfong." In 1776 this was recognised as a triple copper-nickel-zinc alloy. It is highly probable that it was the product of cementation, much as calamine-brass was, and wide variations in the percentages of the three metals which enter into its composition are therefore not surprising.

Platinoid is a German silver supposed to contain about 2 per cent. tungsten. It must be confessed, however, that analysis often fails to reveal the tungsten. It is much used in electrical work owing to the fact that its resistance, which is very high, does not vary with changes of temperature.

Antifriction alloys, so much in use for machine bearings, often contain large percentages of zinc, antifriction metal itself with 85 per cent. and Babbitt's metal with 69 per cent. being typical representatives.

Zinc and aluminium alloys, although not in so general use as they deserve to be, offer many points of usefulness, as also do the so-called aluminium-brasses—copper-zinc alloys with a small proportion of aluminium. The zinc-aluminium alloys vary in properties with the proportions of the components. Those relatively high in aluminium are very light and strong, and have found use in the manufacture of scientific instruments. Those in which the zinc is increased, and a small quantity of copper added, cast and machine well for motor-car work. The content of zinc varies from 10 to 20 per cent. as a rule, and in no case is an alloy of any practical value produced if the zinc rises to 40 per cent. or over.

The triple alloys usually referred to under the generic terms of gun-metal and bronze are many in number and extraordinarily varied in composition. They consist typically of high copper, relatively low tin, and lower zinc. Where the true bronzes end and the gun-metals begin is hard to define, the two terms being often very loosely used. A standard Admiralty alloy consists of 88 copper, 10 tin, and 2 zinc, and there are many gradations between the 1 per cent. of zinc contained in the bronze coinage of the Realm and the 10 or 15 per cent. in some other members of the class. The true bronzes are essentially copper-tin alloys, but by the addition of zinc in increasing amounts, and the elimination of the tin, a great series of alloys results which ultimately shades off into the brasses.

It would not be possible to refer in specific terms, however briefly, to all the useful alloys into which zinc enters as a substantial constituent. The part which it plays in such may be judged from recently published standard works* on the subject, which refer to them rather by the hundred than the score. The range covered by them is, perhaps, best indicated by expressing in tabular form some thirty typical examples (see page 521).

Neither lead nor iron form with zinc alone alloys of any use in the arts, but both gold and silver have a great affinity for zinc, this property forming the basis for the Parkes process, now in such general use, for the extraction of the precious metals from lead containing them, and to which more extended reference will be made later.

The physical properties, and characteristics generally, of zinc alloys are greatly influenced by the manner in which they are compounded, the order in which the constituents are incorporated, and the temperature at which they are poured. This is not surprising in view of the comparatively low melting- and boiling-points of zinc. Copper, for instance, has a melting-point considerably higher than that at which zinc volatilizes.

For such reasons the zinc is the constituent generally added last, and that immediately prior to pouring. In the preparation of all brasses the copper should be melted first and exposed to the air as little as possible, as it has the property of dissolving, not only the cuprous oxide formed by the consequent oxidation, but oxygen itself. These influence the character of the alloy, and further to that, if excessive absorption has been allowed to take place, the subsequent incorporation of the zinc may be attended by violent reaction and ebullition—sometimes even almost of explosive violence—

* "Mixed Metals," Hiorns, London, 1912; "Alloys and their Industrial Applications," E. F. Law, London, 1914.

ZINC ALLOYS.

Alloy.	Zn	Cu	Sn	Pb	Fe	Sb	Ni	Mn	Al	Remarks.
1 Tombac . . .	2·8	97·8	..	..	..	..	..	..	..	Viennese, used for buttons.
2 Pinchbeck . .	6·4	93·6	..	..	..	..	..	..	..	—
3 Tombac . . .	8·0	92·0	..	..	..	..	..	..	..	Parisian red Tombac.
4 „ . . .	10·0	90·0	..	..	..	..	..	..	..	French Oréide.
5 „ . . .	15·0	85·0	..	..	..	..	..	..	..	Imitation gold jewellery.
6 „ . . .	20·0	80·0	..	..	..	..	..	..	..	Dutch metal for imitation gold leaf.
7 Brass	25·0	75·0	..	..	..	..	..	..	..	Rolled sheet brass.
8 „	30·0	70·0	..	..	..	..	..	..	..	Cartridge brass.
9 „	33·3	66·6	..	..	..	..	..	..	..	Common brass.
10 „	34·6	65·4	..	..	..	..	..	..	..	For good brass wire.
11 „	40·0	60·0	..	..	..	..	..	..	..	Muntz metal.
12 „	32·5	65·0	..	2·5	..	..	..	..	..	Clock brass.
13 „	38·0	60·0	..	..	2·0	..	..	..	..	Sterro metal.
14 „	35·66	60·0	1·74	1·41	0·76	..	..	..	..	Delta metal.
15 „	41·6	54·9	1·36	..	1·16	..	..	0·47	0·4	Good manganese bronze.
16 „	38·0	60·0	..	..	..	..	..	..	2·0	Aluminium brass.
17 „	44·0	54·0	..	2·0	..	..	..	..	..	Very common brass, turns well, but quite unfit for rolling, etc.
18 Naval Brass . .	37·0	62·0	1·0	..	..	..	..	..	..	Admiralty specification.
19 White „ . .	30·0	5·0	65·0	..	..	..	..	..	..	—
20 German Silver .	20·0	46·0	..	..	..	..	34·0	..	..	Finest German silver.
21 „ „ .	20·0	50·0	..	..	..	..	30·0	..	..	Fine white German silver.
22 „ „ .	36·0	57·0	..	..	..	..	7·0	..	..	Low grade „ „
23 „ „ .	28·0	56·0	..	..	..	..	16·0	..	..	Good „ „
24 „ „ .	25·0	50·0	..	..	..	..	10·0	..	..	With 15 of silver, for Swiss nickel 20-centime coins.
25 Bronze . . .	1·0	95·0	4·0	..	..	..	..	..	..	British bronze coinage.
26 Gun Metal . .	2·0	88·0	10·0	..	..	..	..	..	..	Admiralty No. 1.
27 Motor Alloy . .	10·0	2·0	..	..	..	..	..	..	88·0	Light strong alloy for motor-car work.
28 Babbitt's Metal .	60·0	4·0	19·0	5·0	..	3·0	..	..	..	For bearings.
29 Bearing Metal .	20·0	76·0	3·0	1·0	..	..	..	..	..	Daimler motor-bus bearings.
30 Vaucher's Alloy for journal-lining.	75·0	..	18·0	4·5	..	2·5	..	..	..	Antifriction alloy.

leading to loss of metal and variations in the composition of the alloy.

Much of the brass produced is drawn into wire, and an interesting example of a compound wire is presented by that wherein copper rods were subjected to cementation with pure calamine and carbon at a temperature slightly under that of the melting-point of the metal, which became thus transformed on its exterior portion into brass. The drawing of these rods produced a wire which consisted of brass with a core of copper, and allowed of the production of very fine filaments which formerly found considerable use in the manufacture of imitation gold lace.

All zinc alloys, and particularly the brasses, are extremely susceptible to thermal treatment, and in the drawing of important articles from plates of even the finest of brass frequent annealings and pickling, to remove the consequent scale of oxides, are necessary for proper and successful working. In no branch is this more important than in working brasses destined for the manufacture of munitions of war, such as heavy cartridge cases.

Galvanising.—The operation of galvanising consists in coating iron or steel sheets, wire, netting, or other articles with a thin pellicle of zinc which is sufficiently adherent to protect the metal underneath from rusting and decay.

The process was invented by Crawford in 1837, and is performed simply enough by passing the heated sheets or other articles, previously pickled in dilute sulphuric or hydrochloric acid, through a bath of molten zinc. The object of the pickling is to present a chemically clean surface of the iron for the attachment of the zinc, and the operation, if properly carried out, results in a more or less firm attachment by reason of the actual formation of a contact alloy of zinc and iron.

The temperature of the galvanising bath determines the thickness of the coating; the hotter the bath the thinner it is, and the sheets may be passed, after their passage through the bath, between rolls to remove superfluous zinc. Galvanised sheets often exhibit a beautiful *moiré-antique* surface due to the crystallisation of the zinc, as in the specimen plate submitted.

From the descriptive outline of the process it may be judged how misleading the term "galvanising" is. It has no connection direct or indirect with electricity.

It forms the basis of a huge modern industry which is by far the largest consumer of spelter to-day, and the galvanised wire netting and corrugated roofing sheets must be so familiar to all as to need no laboured description.

The latter third of the last century witnessed a great extension of the industry, which called for very large quantities of spelter. A reference to the chart (see page 528) giving the zinc production curve from 1845 onwards shows how, soon after 1870, the production leapt forward, the influence causing this being in no small degree the call for the metal for galvanising.

The passing of the articles through the galvanising bath gives rise to the ultimate formation in the bath of a zinc-iron alloy known as "hard zinc." Being less fusible than zinc itself, it forms hard crusts at the bottom of the bath, and has to be removed from time to time. Part passes into commerce for use where a zinc-iron alloy is required, and the remainder is redistilled.

Rolled Zinc.—Zinc lends itself well to rolling into sheet form provided that it be not too high in lead and iron, and that the operation be carried out at the temperature at which it is ductile.

In practice the usual custom is partially to refine spelter in large liquation furnaces of reverberatory type, so as to reduce the lead-iron contents to the minimum practicable by such methods, and to cast the metal into ingots or plates which, while still hot and at the correct temperature, are rapidly passed through rolls until the correct gauge is attained. Very little rolling is done in England, the bulk of it being carried on in Silesia and Belgium; there are also rolling-mills in the United States. Such zinc sheeting finds most extended use on the Continent, where it is used to a very large extent indeed for roofing, either in the original sheets, or in ornamental stamped tile form nailed on exactly as slates are.

As roofing, particularly in the inclined position, it is durable, light, and efficient, and although it has as yet found little application in the United Kingdom for this purpose, the reasons are certainly not due to the shortcomings of the material. True it is that it is inflammable, but that only under conditions likely in any case to destroy the building roofed with it. So important and extended are its uses for roofing in Continental countries that the spelter market may be very materially influenced by the prosperity or otherwise of the general building trade. Fine sheets in perforated form are used as screens and sieves; their use in thinner gauge and unperforated form for the lining of airtight wooden cases, hermetically

sealed by soldering, must be familiar to everyone who has been in tropical countries.

Thick rolled zinc plates, sawn to suitable sizes and drilled for bolting, are used to a considerable extent in marine boiler work to prevent corrosion of the boiler plates. The highly electro-positive zinc, fastened within the boiler, receives the attack, and can be renewed from time to time.

Rolled zinc plates of specially high quality find important use in the photographic reproductive process known as photo-zincography, and in photo-etching.

Thin zinc sheeting stamped with varied ornamental designs in relief has of recent years found a very considerable use for ceilings, and its uses for dozens of articles in ordinary domestic use, such as bath-tubs, pails, toys, etc., must occur to everyone.

We owe the satinised surface finish on many of our better-class papers to the use of hot zinc sheets with a fine homogeneous surface.

Under the heading of sheet zinc may very properly be placed the filamentous zinc or zinc shavings which are used in considerable quantities for the precipitation of gold and silver from cyanide solutions. This use of the metal plays a most important part in the metallurgy and supply of both of the precious metals named. Circular discs stamped from rolled zinc sheets are threaded on a mandrel, clamped, and placed in a turning lathe. By means of a fine tool traversing the cylinder so formed the zinc is removed in the form of very fine wire or shavings, which in proportion to weight expose a great surface area. These shavings are used in the extractor-boxes of plants employing the cyanide process for extraction of gold and silver from their ores, the highly electro-positive zinc decomposing the double cyanides of gold or silver and potassium or sodium, resulting in the deposition of metallic gold or silver, and the formation of the cyanides of zinc. For this purpose zinc containing a small percentage of lead is the most efficient, as the zinc-lead couple formed thereby accelerates the precipitation.

Zinc is also extensively employed in the metallurgy of gold and silver in the Parkes process for refining of base lead bullion produced from the smelting of gold-silver-and-lead ores. The base bullion, treated in softening furnaces for the prior removal of copper, tin, arsenic, and antimony, is melted in large cast-iron or steel hemispherical kettles; zinc is added and stirred in, when it forms a preferential attachment with some lead to the gold and silver. On cooling down the kettle contents somewhat this alloy rises to the surface as a crust, and is skimmed off, pressed to expel superfluous lead, and the resultant distilled to remove the zinc. There then remains a very rich lead-gold-silver alloy, which is cupelled for the precious metals. The desilverised lead bath still contains a small amount of zinc, which is easily removed by oxidation, either by air or dry steam, and there then remains the soft lead of commerce.

From the two examples given one may see what a really important part zinc plays in the supply of our precious metals, and consequently of finance. There are probably few of us who, when handling a sovereign, pause to reflect that at one stage of its evolution it was quite probably either being deposited from a cyanide solution upon zinc filaments, or alloyed with zinc in course of its dissolution of partnership with lead in a Parkes refinery.

Thus does the humble mouse of the metallurgical world free from its bondage the lion of Finance, and clothe the bare skeleton of Science with the warm flesh of Romance.

Zinc rods ½ in. in diameter and about 7 in. long are consumed in considerable quantities in the Leclanché battery cells used in the telephonic and electric bell installations. There are, indeed, few houses or offices of any importance where such do not exist, and although usually stowed away "out of sight and out of mind" in a dark and dusty corner, they do their work faithfully enough for us. These rods may be cast, rolled, or extruded, and from time to time have to be renewed as they waste away. It has recently been found that fine-zinc rods are much superior to and more economical than those manufactured from ordinary spelter, owing to the absence of "local action" induced by the presence of lead and other impurities. A sample of such a fine-zinc rod produced by extrusion is submitted. At present these rods have not found the universal adoption to which their undoubted economic merits entitle them.

No particularly novel avenues for the consumption of zinc in any great quantity have been opened up in recent years, nor can it be claimed that any are in sight. Galvanising, sheet-rolling, and brass-making utilise the bulk of the spelter produced, and, although no statistics are available, probably in the order named. Its application in the form of zinc sheet roofing has hitherto found but limited scope in England, and any extension in this direction will inevitably meet severe competition from the many new and efficient roofing materials

of the "Ruberoid" and other types which have now appeared upon the market.

Zinc Dust, Blue Powder, or Poussière.—This material has already been referred to as collecting in the prolongs attached to the condensers in distillation. When zinc vapour in dilute form in a reducing atmosphere is cooled, or when in enriched form it suffers a sudden drop in temperature, the resultant condenses, not as fluid metal, but in pulverulent form consisting of an infinite number of globules forming a powder. We have an entirely analogous case in the formation of dew as compared with rain. Microscopical examination indicates that each globule has an extremely tenuous coating of oxide which prevents its coalescing with its neighbour when heated to a point exceeding that of molten zinc, and unless this coating be removed by ammonium chloride, or a similar flux, the powder is most difficult to convert to molten metal.

In this form of dust or powder it presents an enormous surface area as compared with its bulk, and constitutes essentially metallic zinc in an extremely fine state of division. As such it exhibits all the properties we might expect, and is one of the most active metallic reducing agents known. It is oxidised readily, and decomposes water or steam; in fact, if wetted when in bulk it will fire, and the mere moisture present in the air will sometimes cause it to ignite. Serious fires and even explosions have been caused in this manner.

Its value for commerce depends upon its content of zinc in the metallic state, and the best of grades contain from 86 per cent. to 92 per cent. as such. It finds extensive use in the dyeing and textile industries as a reducer, and for the removal of copper, arsenic, antimony, etc., from electrolytic solutions contaminated with these metals.

It has latterly found increasing favour as a precipitant in the cyanide process in lieu of zinc shavings, and the small amount of lead it usually contains acts beneficially in promoting more rapid and complete precipitation of the gold and silver.

Probably the most interesting use to which zinc dust has been applied in recent years is to the process of "Sherardising,"* or dry galvanising. The articles to be coated are pickled to present chemically clean surfaces, dried, and packed into a clean drum or box with zinc-dust. The drum or other receptacle is put into an oven, gradually heated to the required temperature, and then maintained at that for the requisite period. It is removed, cooled, and, when emptied, the articles are found to have received an even coating of zinc. The temperature required varies with the size and nature of the articles, and may be stated in round figures as from 200° to 400° C.—well under the melting-point of zinc.

The zinc deposited in this manner forms a true alloy at the junction, and becomes really an integral part of the article. It will not, therefore, scale or peel off. The coating given may be varied at will from the thinnest up to 14oz. per square foot. Such articles as screws, nuts, bolts, and others of more or less complex description can be evenly and thinly covered with a protective coating, without lumps, and without filling crevices and corners. The coating can be highly polished, and is then as bright and attractive as nickel plate, otherwise it has rather a dull frosted-silver effect.

The zinc really roots itself into the metallic surface of the article treated, forming an alloy, and upon that appears to grow particle by particle in an almost molecular manner. The coating is, therefore, of an entirely different nature to the pellicle of zinc obtained by ordinary galvanising, and is much more like an electro-deposit.

The author has experimented in this manner with copper, and finds that the action is most successful, although for obvious reasons the application to this metal is not likely to be of importance, such as would attach to metals which so readily corrode when unprotected, as iron and steel. One very curious fact came out in the experiment—viz., that at quite low temperatures, far below the melting-point of the zinc even, the point of union of the two metals consisted of typical yellow-brass, indicating an interesting case of the diffusion of solid metals. A "Sherardised" penny-piece and other examples are exhibited as specimens.

It is greatly to be regretted that this really beautiful and efficient process has not received the wide use and recognition to which its merits undoubtedly entitle it.

Zinc Compounds.—By far the most important compound of zinc from every point of view is the oxide—ZnO. Zinc, or zinc vapour, burns readily in air, producing the woolly-white substance formerly known as *Lana philosophica*—philosopher's wool. It is an amorphous snow-white material with a soft greasy feel between the fingers. The oxide exists in other forms.

* "What is Sherardising?" A pamphlet descriptive of the process invented by Sherard Cowper-Coles.

such as the native mineral (zincite), which is in a totally different molecular condition. When ignited at a high temperature it shrinks and becomes hard and gritty. It is infusible at all ordinary temperatures, but distinctly volatile at a white heat. Upon heating it assumes a canary-yellow colour, which usually disappears on cooling, but may be retained to some extent with certain varieties.

As used in commerce it is usually prepared—

(*a*) By the combustion of metallic zinc; or

(*b*) By the blowing-up grate method, under which oxidised zinc compounds or ores—such as low-grade calamine, franklinite, etc.—are mixed with coke or anthracite coal and burned in a specially designed furnace on a perforated cast-iron grate with a blast of air directed underneath. The resultant zinc oxide, after passing a combustion chamber and settling flues, is filtered out in a series of linen or woollen bags, whence it is periodically removed by shaking.

As its value depends upon its purity of whiteness, lead, cadmium, and the presence of fuel ash detract largely from it. The first-named method of production is practised largely in Europe, and the latter in the United States, which affords such quantities of the eminently suitable raw materials already referred to. The blow-up oxide so obtained is usually considered as superior even to that resulting from the combustion of zinc.

Impure forms of oxide are obtained in other ways, as in the treatment of highly zincy slags produced in lead smelting, and these, when not too high in lead or cadmium, lend themselves to the production of special grades of spelter, or even fine-zinc, by the ordinary distillation methods. The specimen of zincy concretion from iron blast-furnace work which is exhibited in connection with this paper is no more than an impure form of zinc oxide.

Zinc oxide, with its purity of white and other valuable characteristics, finds to-day great use the world over in paints, pigments, and enamels. It has good body and covering power, is non-poisonous, and is not blackened by sulphuretted hydrogen. It blends well with barium sulphate, which, owing to its cheapness, is a widespread adulterant. The author has purchased certain specimens of guaranteed pure zinc oxide, which, on analysis, afforded 80 per cent. of barium sulphate. In the trade the oxide is often termed zinc-white. It finds considerable use also in rubber and linoleum manufactures, and in medicine it appears in the common zinc ointment.

Zinc Sulphate, sometimes known as zinc vitriol, is usually prepared by the solution of zinc or zincy waste in sulphuric acid and the crystallisation of the salt. So obtained it contains seven molecules of water of crystallisation, and appears as colourless needle crystals with a strong metallic-astringent taste. It is also prepared by the sulphate-roasting' of zincy ores, often in heaps, followed by leaching.

It finds use as a mordant in the textile industries and in the manufacture of glue, where its function is that of a clarifying agent and preservative.

In medicine it is employed as an astringent, and a very weak solution forms a common eye lotion. Apropos of this, the author remembers an amusing instance of years ago at Goslar, where an astute and enterprising man sold the ordinary water of the well-known Rammelsberg Mine, in the Hartz Mountains, for this (and other) supposed miraculous virtues. The ordinary water of this mine is well charged with zinc sulphate, and had his local patients only known it they could have had many thousands of gallons for nothing.

The greatest quantity of zinc sulphate finds its utilisation in the manufacture of lithophone, which is a mixture of zinc sulphide and barium sulphate produced by double precipitation employing barium sulphide and zinc sulphate. It is a stable pigment, much cheaper than zinc oxide, but suffers from one grave defect in that it is affected by light and does not retain its purity of white, turning grey, or even greyish-black, in strong sunlight. It recovers its whiteness on being retained in darkness for some time. The manufacture of enamel paints and linoleum absorbs a good deal of lithophone. The basic idea underlying its use at all is to obviate the necessity for the much more costly zinc oxide for which it is a substitute.

Zinc Chloride is a waxy, extremely caustic substance obtained usually by the dissolving of zinc-scrap in hydrochloric acid, followed by the evaporation of the solution; the latter is by no means easy if the whole of the water is to be eliminated. It melts easily at 262° C., and at rather over this sublimes with the production of peculiarly irritating fumes.

As a preservative for timber it is well known and has been much used for railway sleepers, either in combination with creosote or without. The textile industry absorbs material amounts, and it is used in "mercerising" or giving the appearance of silk to cotton goods. It is extraordinarily hygroscopic, and if the solid

chloride be exposed to damp it will gradually absorb enough moisture to go into solution. It attacks cellulose when in the form of a strong solution, and one of specific gravity 1·7 boiled with excess of zinc oxide gives an oxychloride which will even dissolve silk.*

Zinc chloride in solution is a powerful disinfectant and germicide, as also is the iodide, which is used in minute quantities. Those who have, at the dentist's hands, been unfortunate enough to receive an application of zinc iodide and iodine will have had every inducement to retain a permanent recollection of the occasion.

Of the evil and debased uses to which our good friend zinc may be put we have only recently had two examples. In the one an etched zinc plate was used to counterfeit the watermark in an extensive forgery of Treasury notes, and this so perfectly, as evidenced by the prosecution, that it was difficult to detect the difference on comparison with a genuine note. In the other, to no stranger or more historically interesting use has zinc surely ever been put than for coinage to replace the nickel currency withdrawn for munitions of war. Yet the Germans have done this in Belgium, and the author has two such coins in his possession, one of the nominal value of 10 centimes and the other of 25.

VI.—The Production of Zinc and its Position in the Metal Markets of the World.

Leaving out of account iron and steel, the metals in most common use are, in their order, lead, copper, and zinc. The world's supply of these three is such that in the year 1913—the latest for which figures are available—we had :

	English tons of 2,240 lbs.
Lead	1,070,000 (estimated).
Copper	986,500.†
Zinc	985,142.†

Stated in a ready way, therefore, for every 1,000 tons of lead produced there were 921 tons of copper and 920 tons of zinc. Analysis in this manner will perhaps afford a ready mental concept of the relative position occupied by zinc in the Arts and Commerce. The close coincidence between the figures for copper and zinc for the year cited is at least remarkable, as indeed between those for all three metals.

Owing to the disturbance caused by the war it is doubtful how far this ratio is to-day strictly preserved; what the position may be at the conclusion of peace, and for some time afterwards, is vouchsafed to none of us to predict in any terms beyond those of mere guess. Much will depend upon the condition in which those great European centres of spelter production—Belgium, Upper Silesia, and Rhineland—are left, coupled with the very considerable extension of the smelting industry which has already taken place in the United States, and is by no means at an end. Russia, Japan, and Holland will almost certainly also figure in material productive increase, although in lesser degree. So far as Britain is concerned we may confidently predict an increase in production, the degree being dependent upon the manner in which the proposition is approached and handled. If certain comprehensive schemes, which have recently been outlined, for the treatment of Imperial ores in the United Kingdom come to fruition, the increase may be great indeed. Imperial matters call for Imperial methods, and any attempt to deal with such in "penny numbers" usually brings its own reward. The commercial metallurgy of zinc is, as we have seen, closely interwoven with that of other base metals such as lead, and that of silver, also with the production of sulphuric acid on a considerable scale; its successful establishment in any given area necessarily takes keen cognisance of this material and fundamental basis.

How far these major schemes may succeed in their object, without the recognition that the subject is of national importance and calls therefore for the support of the nation, remains to be seen. The war has supplied the much-needed lesson, are we but in position to appreciate it at its proper value and profit thereby.

The world's annual production of spelter, as nearly as may be ascertained, is given on p. 527.

The imports of spelter into England, as taken from Board of Trade returns, totalled in 1913 to 145,004 tons, approximately 14·5 per cent. of the world's production for that year other than domestic, viz., 58,298 tons, of which probably not more than 31,290 tons were "primary" spelter in the sense of being extracted from ores, the balance of 27,008 tons being the result of treatment of by-products, galvanisers' ashes, hard-spelter, etc. The domestic production, including even as it does so abnormal a proportion of "secondary" metal, amounts to, at the outside, a mere 5·9 per cent. of the world's total annual supply. For the year cited the imports, at the average

* Ingalls, "Metallurgy of Zinc," 1903, p. 687.
† Based upon figures from "Mineral Industry," Vol. XXII.

ruling price for spelter "ex ship," reached a total value of no less than £3,291,772.

THE WORLD'S PRODUCTION OF SPELTER.

Year.	English Tons of 2,240 lb.	Authority.
1845 . .	29,000	Based upon figures as quoted by Ingalls, "Production and Properties of Zinc," New York, 1902, and Liebig, "Zink und Cadmium," expressed to nearest 1,000 tons.
1855 . .	70,000	
1865 . .	98,000	
1875 . .	166,000	
1885 . .	294,000	
1890 . .	342,000	
1895 . .	406,000	
1900 . .	471,460	*Mineral Industry*, vols. XIV.-XXII. These figures include "secondary" spelter produced from old material, galvanisers' ashes, and the like.
1901 . .	508,422	
1902 . .	544,193	
1903 . .	561,547	
1904 . .	612,687	
1905 . .	648,906	
1906 . .	688,821	
1907 . .	725,616	
1908 . .	711,514	
1909 . .	762,559	The United States, in 1913, produced 31·4 per cent. of the world's total.
1910 . .	797,336	
1911 . .	880,411	
1912 . .	955,398	
1913 . .	985,142	

The *Engineering and Mining Journal* of New York, in its issue of April 1st, 1916, contains an exhaustive review of the United States spelter statistics for 1915, and it makes extraordinary reading. The author is that well-known writer W. R. Ingalls, and he computes the spelter production of the United States for 1915 at 452,000 English tons, of which probably no less than 55 per cent. was the result of natural gas firing.

He says "the manner in which spelter production in 1915 was expanded is one of the romances of our industry." For 1916 an output of at least 714,000 tons seems assured, much of it, no doubt, from smelteries which exist only for the purpose of reaping the present harvest, but much also from plants of a very permanent description which cannot fail to exercise a potent effect upon the economics of zinc for years to come.

I would earnestly invite the attention of all interested in the metal to this article, in the reading of which it is not amiss to bear in mind that, in addition to being a great producer of zinc ores, the United States, amongst other advantages, enjoys complete immunity from munitions control and excess profits tax.

A chart is submitted (p. 528) upon which has been plotted a curve indicating, from 1845 to 1913, the world's zinc production.

Prior to 1845 the statistics are not very reliable, and in any case the tonnage was so small as to have little bearing upon the metal in relation to the part it to-day plays in our commerce.

From 1845 to 1900 the periods adopted are quinquennial, and this with the set purpose of eliminating yearly fluctuations and giving a truer mean curve of the productive increase.

From 1900 onwards yearly periods have been plotted.

The curve is a remarkable one, and indicates the ever-increasing relative rate of production, particularly marked points occurring about 1873 (due to the progress of galvanising), 1900 and 1908. The increase from 1900 to 1913 is truly astounding.

It is by no means easy to arrive at true figures for the yearly production of the world. The complications introduced by primary and secondary spelter, and redistilled hard and other spelters, are not to be neglected. The meticulous accuracy, therefore, implied by stating to the units, or even the odd hundreds, is probably more apparent than real. The tonnages stated have, however, been gathered from the best and most reliable sources available, and enable us to state beyond fear of contradiction that in the relatively short space of sixty-eight years the world's output has increased about 3,400 per cent.!

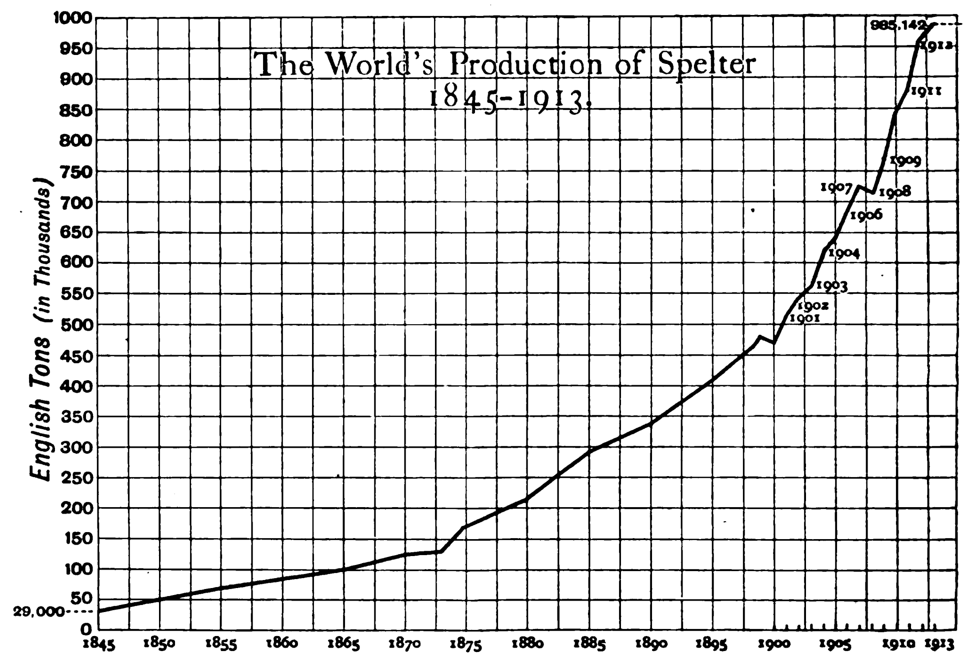
The market value of spelter has, not unnaturally, fluctuated considerably when viewed over a considerable period of years.

When first produced it realised a high price, which rapidly fell as production increased and no new output for its consumption opened out. In 1807* it was about £40 per ton, rose in 1808 to £84 per ton, and then fell steadily as production overtook demand, until in 1820 it stood at no more than £11.

* The prices quoted, 1807 to 1850, are based upon figures as given by Liebig: "Zink und Cadmium," Leipzig, 1913.

The extension of sheet-rolling caused the price to rise until in 1825 it reached £30; it fell again as production rose, and between 1830 and 1836 fluctuated between £10 and £19. It again fell to £10 in Breslau (the Silesian centre) in 1848. In 1850 it was quoted at about £16, and from that time onward to 1913 the yearly average fluctuated between £13 19*s*. 11*d*. (the lowest, touched in 1885) and £27 1*s*. 5*d*. in 1906.

The general tendency of later years has been towards a distinctly higher average level. For a very long time low wages, and easily won and treated ores, kept the price low. As wages increased and difficulties of treatment arose the improvements in metallurgical efficiency and extraction kept pace up to a certain point and compensated the producer. Beyond this point there was bound to be a rise in average value, and we see this clearly reflected in the facts that only twice since 1898 has the average yearly price been below £20, and never since the close of 1902.



Industrial conditions had reached such a point that, broadly viewed, a £20 market was unremunerative—distinctly unprofitable in particular for those concerns which did not themselves possess mines.

There is no gainsaying the fact that there is no branch of the metallurgical industry in which, considering the difficulties and risks involved, the invested capital has been so ill-requited as that of zinc. That this is not the popular impression the author is well aware. What profits there have been, however, were made largely by the ore and metal-dealing firms, and those who, in addition to smelting, turned out rolled and stamped zinc together with lead, and silver from complex ores—and possibly also zinc oxide.

Recently a great deal of unfortunate nonsense has been written and woven about the zinc position—obviously by people totally unqualified to express an opinion of any value—and as this has been widely published, it will be no easy matter to replace it in the public mind with a true perspective of the facts.

We have been informed, for instance, that the superior acumen, industry, and technical knowledge of the Germans enabled them to obtain control of and treat practically the whole of the huge output of Australian zinc concentrates. Obtain control they did, retaining it up to the outbreak of war, but treat the concentrates, except in relatively minor quantities, they did not. They utilised this control to make money, in which they were most successful, passing the major part of the concentrates on to the Belgian works for smelting. Of the total Australian output Belgium smelted at least 75 per cent., and Germany only 14 per cent. They had placed themselves in a position to force this on the Belgian works by acquiring at the outset a controlling interest in a number of them.

What we have now to see to is not so much

the hasty establishment of domestic zinc smelting works on an unprecedented scale, as the effective dissolution of Teutonic control once and for all. This, coupled with the energetic establishment of the smelting industry on well-thought-out and supported lines is, in the author's opinion, the soundest line of attack for the successful solution of the problem.

Until August, 1914, the European spelter market was controlled by an organisation known as the Spelter Convention, which regulated practically the whole of the metal output and price. War, of course, put an end to any question of our supply coming from Germany, and as Belgium fell into the hands of the enemy this source, too, was closed to us. The net result has been to throw the control, so far as the chief allied nations are concerned, into the hands of the United States—where it is likely to remain at least as long as the war lasts.

Germany has abundant spelter; her domestic ores and established smelting industries, to say nothing of those in Belgium, ensure this. Spelter is there to-day quoted at about £28 per ton. The Allies, on the other hand, have abundant ore supplies, and but limited facilities for treatment. We depend, therefore, on the United States for the bulk of our supply, and pay £100.

We are now in the anomalous position that, with the control of the seas and a plethora of the potential source of the zinc in the form of ores, we are driven to oversea countries for the metal at famine prices. Control of the seas, vital as it is, will not bridge the gulf between ore and spelter—and the moral is obvious.

It may be noted that the specimens of metallurgical products and manufactures exhibited are of strictly British origin in all save one or two instances.

The writer is deeply sensible of the shortcomings of this attempt to deal with a subject of such range and importance within necessarily limited compass. Written in the scanty leisure which the professional man employed in the production of munitions of war can to-day afford, it has been completed, such even as it is, with some difficulty. The generous indulgence of the reader is craved on these grounds. Not the least of the difficulties has been to decide, not what to include, but what to omit.

If, however, it may happily succeed, through the medium of this distinguished Society, in securing the wider appreciation of a national although comparatively little known subject, the author will feel that he has not entirely failed.

DISCUSSION.

Sir Gerard A. Muntz, Bt., in opening the discussion, said the paper was most instructive to men who had been engaged in handling this metal all their lives, and was even more instructive to the general public who had no previous knowledge of the matter. The author had given a very wide view of the possibilities of zinc production in this country, and had laid emphasis on the importance of it with regard to our present position in the war. As a manufacturer using a large quantity of zinc for munition purposes, he confirmed what had been said as to the difficulties experienced in the first instance in getting sufficient zinc to cover the requirements of the Army and Navy. It was felt in trade circles that it was quite time the zinc industry in this country was brought not only level with, but ahead of, other countries. The future of the zinc industry lay very largely in what had been described as "fine-zinc." Fine-zinc was more or less a modern product; ten years ago it was "fancy goods," and its possibilities in manufacture were very little understood even yet; people still looked upon it as a thing only of use in the manufacture of cartridges and high-grade brasses, but it had a great many more uses in the manufacturing world, and it would well repay any trouble taken with regard to it. In connection with supported industries, it was gratifying that at last the Government had awakened to the fact that its duty was to govern and not to look on; an Advisory Council on the subject of science and industry had been formed, and the Government were supporting researches in all sorts of directions, some of which had borne very good fruit indeed. Everybody in a position to do so should bring influence to bear upon the Government in that direction.

Mr. C. F. Courtney (General Manager in Australia, Sulphide Corporation) said the subject of the paper was particularly interesting to him, not so much from its scientific aspect as on account of his close association with Mr. Moulden for very many years in connection with the spelter industry in Australia. It being Empire Day, it was interesting to note that Mr. Moulden was born in South Australia. He joined with Mr. Moulden in hoping the matter would be considered by the Government, and that there would in the future be a far larger amount of spelter in this country than there had been in the past. Great difficulties had been caused in consequence of the very small production here. Regarding the question of concentrates, they were fully alive to the enormous leaps and bounds that had taken place in flotations of that method which had brought into use double and treble the deposits of the world that had been possible in the past. It was difficult to say what effect that would have on its price in the future, but if it was cheaper they would all benefit, and if it was dearer they would not be very much worse off.

Mr. Edward Brand said for many years he had taken a great deal of interest in the zinc question. It had been said by some, unjustly as he considered, that America had been keeping zinc products from coming to this country; the difficulty had arisen through the lack of shipping; otherwise the Americans would willingly have allowed their import here. The author had referred very casually to "plates of spelter," which was rather a confusing term. The best spelter was known as "fine spelter," for which the common trade term was "virgin spelter." The next grade was known in the trade as "remelted spelter," and that was where pieces had been cut and used, and then thrown back and remelted. After treatment in the galvanising bath the spelter run from the furnace was called "hard spelter," which was the cheapest and commonest grade. Unless one knew the difference between the various qualities, one was apt to go wrong in any experiments made. Zinc oxide could be made from the best quality spelter, and then the finest quality of zinc paint could be produced. On the other hand, if hard spelter was used a very common and inferior article was obtained.

Mr. W. E. Oakden asked the author if he could throw any more light upon the question of the failure of the electrolytic processes which had been carried on in England, and why they were likely to be more successful at the Anaconda Works?

Professor H. C. H. Carpenter, M.A., Ph.D. (Royal School of Mines), said that two years ago he had the pleasure of visiting the Anaconda works, where they were installing the plant to which reference had been made. It was rather difficult to test the electrolytic production of zinc by the Anaconda works; they were very large works, treating enormous quantities of copper ore on a big scale, and the production of zinc there would work in with that of other metals in the plant. It was questionable whether, even if it paid the Anaconda works to treat zinc ores in that way, it would necessarily be a solution of the problem for other districts where zinc ores existed. He desired to pay his tribute to the remarkable metallurgical skill of the staff at Anaconda; he had visited many works in America, and formed the impression that at Anaconda they had the high-water mark of technical skill. Another important question was: Were we going to have a greater production of zinc in the British Empire? Twenty-one months after the outbreak of war the position was very nearly the same as before. Mr. Holloway had recently said the production of zinc in this country was less now than at the outbreak of war. That was a serious state of affairs. Mr. Holloway had lately returned from America, and said there was no doubt that country was going to be a formidable competitor of this country. America had increased its production of the metal enormously, the rate of production being 800,000 tons a year at the present time; the works had been making very large profits and had used those profits wisely, spending the money on improving their plant, making it as efficient as possible, and accumulating great financial reserves. The competition of America would have to be faced at the end of the war. Being connected with the Royal School of Mines, it was a great pleasure to him to remember that Mr. Moulden, the winner of the medal which had been presented, was a Royal School of Mines man, and the second place had been gained by another Royal School of Mines man. They were proud of their associates from that institution.

Professor Thomas Turner, M.Sc., A.R.S.M., F.I.C. (University of Birmingham), said that for a number of years he had been using Mond zinc from time to time, and he knew the output of Messrs. Brunner Mond had increased steadily. He believed they had been turning out some thousands of tons annually of very pure spelter. Since the war had begun, Messrs. Chance & Hunt had commenced the supply of electrolytic spelter of the same quality; their output had gone on increasing considerably, so that there was ground for hoping that pure zinc would be produced in this country in increasing quantities. It would be noticed that the firms producing such zinc were chemical manufacturers who had a by-product with which to commence. The writer of the paper had pointed out an inherent difficulty in zinc manufacture, namely, that the heat of combination of zinc with oxygen was very high, so that there must be a great deal of power to separate the oxygen from the zinc, whatever process was adopted. The temperature at which oxide of zinc was first attacked by carbon was something like 1,050 degrees, whilst the spelter volatilised at something like 150 degrees below. That meant that a high temperature was necessary, and only rich ores could be used. Rich ores were also required for the electrolytic process using calcium chloride waste liquors. The other process for the electrolysis of zinc was applicable to poor ores, where sulphuric acid was available as a result of the roasting of the ore. So there were three problems to be dealt with: (1) the problem of electrolytic zinc from chemical works; (2) the problem of fairly rich ores, the zinc from which must be produced by distillation; and (3) the problem of complex ores containing relatively a smaller quantity of zinc from which one might hope to get electrolytic zinc by processes which would be at all events fairly remunerative when worked on a sufficiently large scale.

The Chairman (Dr. Dugald Clerk, F.R.S.), in moving a vote of thanks to the reader of the paper, said he had had some little experience in the use of zinc, having been a Director of Kynoch & Company for about seven years, during which time they had used a very large quantity of zinc. Even at that time they had electrolytic zinc as well as ordinary zinc, and he would like to hear from Mr. Moulden what was the nature of the process used

at that time. He had lately become aware of a process for depositing zinc electrically from zinc concentrates. A small works was started near Newcastle-on-Tyne, and was now making a good many tons per week at the present high price. That method depended upon pure electrolytic deposition in liquid, not upon the decomposition of a fused electrolyte, as in the case of aluminium electrolysis. That was the electrolysis of which the author had spoken as being more likely to succeed, but at present the wet electrolytic process was used to some extent. He often heard it said at meetings like the present that the English were very much to blame, not only in regard to zinc but in regard to almost every other subject. The curious fact remained that Britain had been very successful; they had all been very busy, and he generally found on examination that those subjects for the neglect of which they were blamed did not pay so well as the other subjects that they continued to work on. That accounted for the rapid increase in the wealth of Britain, which was going on at a very great rate even up to the time of the war. He quite granted that key industries were of essential importance, and Mr. Moulden had made a very good case with regard to the zinc industry being treated as a key industry. Undoubtedly this country ought to be in a position to supply its own spelter for its own munition works. Kynoch's, for instance, were even now turning out twelve million cartridges for the front every week, and every one of those cartridges required very pure copper and very pure zinc, otherwise they would be of no use for the quick-firing guns. Many attempts had been made to produce zinc in other ways. He had happened to become aware of the flotation process which was used by the Sulphide Corporation, a most interesting process of partly English and partly Australian invention. There were two methods: one was oil flotation and the other carbonic acid flotation. He did not know which had obtained the mastery; but some years ago he had occasion to go carefully into the acid flotation and he found many interesting facts about it. Undoubtedly these new processes would help very greatly in the production of zinc concentrates, and those zinc concentrates should certainly be dealt with in this country and not in Belgium or in Germany. He quite agreed with that view, and he believed a number of people were hard at work now on those lines. He could not see that this country was at all lacking with regard to the chemical side of the question, because there were Brunner Mond's and all the great North-East coast firms, Castner Kellner, and so on, many of whom had done good work in electrolytic chemistry.

Mr. J. C. Moulden, in acknowledging the vote of thanks, said that some of the points dealt with in the discussion would be found to be covered by his paper as printed, though he had not had time on the present occasion to develop them. He had been asked why the Anaconda people were likely to make a success of their electrolytic work when other people had failed to do so. He would answer that in the words of Professor W. R. Ingalls, the foremost writer on the subject in the United States of America, who said that there were special circumstances connected with the matter. The Anaconda Company was able to obtain its crude zinc ore very favourably, inasmuch as it worked its copper ore in conjunction therewith. The crude zinc ore lent itself to very successful treatment by the flotation process which gave a high-grade zinc concentrate. This again was of such nature that by roasting and leaching with weak H_2SO_4 the percentage of zinc extracted as sulphate was unusually high. That could not be said of ordinary ores containing, as they so often do, sensible quantities of iron and manganese which formed all sorts of troublesome compounds in roasting, and lowered thereby the percentage of zinc recoverable by lixiviation. The Anaconda process was based upon the electrolysis of zinc sulphate in weak sulphuric acid solution. He had been rather surprised to hear one speaker refer to the suitability of poor ore for electrolytic work, because Professor Ingalls made directly the opposite point, and said that the success of the Anaconda people was due in considerable measure to the fact that they were able to obtain high recovery of the original zinc contents of the ore in so enriched a form and so amenable to treatment that the greater part of the zinc could be easily obtained in the form of sulphate solution. Reference had been made to a number of firms in England who were producing electrolytic zinc to-day. That fact, however, did not touch the main metallurgical question, namely, the addition of British zinc to the world's supply in any considerable quantity from ores. It was true that electrolytic zinc had been produced in this country, but the quantity was very limited, and unless it could be produced in connection with some other chemical industry running side by side with it, the difference in the price between high-grade virgin spelter and fine-zinc had not been sufficient in the past in most cases to warrant people launching out into big works for the purpose of making fine-zinc in that way. Electric smelting had been referred to. He might say that he had been for three years consulting metallurgist to one of the largest concerns in the world, where a system had been employed of electro-thermic smelting, and he had some opportunity of observing what the prospects were likely to be. He was bound to say that the production of zinc by internally created electro-thermic units would in the future, where power was available, have a very far-reaching effect upon the metallurgical side of the question.

FRUIT PRODUCTION IN NATAL.

While fruit from Cape Colony is well known on the market in this country, the products of the Natal fruit industry are almost unknown here. It

may be said that Natal produces no deciduous fruits worth mentioning as compared with her citrus and tropical products. The fact that during the year past plums and pears are to be found amongst the list of exports indicates that there are possibilities for the building up of a trade in these fruits.

According to the report for the year ended March 31st, 1914, of the Department of Agriculture of the Union of South Africa, the advantage possessed by Natal is that all fruit grown in that province is, according to the character of the climate, earlier than that produced in other exporting areas.

Naartjes.—This fruit is placed first on the list because it stands at the head of the 1913-14 season's exports, some 11,000 cases having been sent away. Further, it is at the present time the best of Natal's citrus products. The class of naartje most largely exported is of the tangerine type and known generally in South Africa as "the Natal naartje." It is undoubtedly the best naartje grown in the Union, and is produced to a large extent in the coastal districts north and south of Durban. Export of this fruit lies to a large extent in the hands of dealers, to the exclusion of the actual grower, and it is possibly due to the fact that the largest dealers and exporters are a most painstaking and progressive body of men that such an amount of success has attended naartje export from this province.

Oranges.—Less than 1,500 boxes of oranges were sent away from Natal during the year under review. This is not an encouraging record, and is likely to prove the minimum mark in the history of this industry. The reason why this small quantity only should have gone forward is possibly to be found in the fact that coastal growers have in years past received little encouragement either in prices received or in the way their fruit stood transport. It has finally, apparently, been recognised that the export of coastal-grown oranges is not a reliable business, and so far the up-country grown article has not been available for export in sufficient quantity.

With the development of citrus culture within a radius of a few miles of Maritzburg, and in a few other suitable localities, it is only a question of time before Natal will take her place with her sister provinces as an exporter of good well-grown fruit. The higher uplands of Natal produce as good an article in the way of an orange as most other parts of South Africa, and with carrying qualities equally good.

Minor Citrus Varieties.— These include lemons, limes, grape-fruit, etc. No export of these has taken place; a good local demand exists for limes and lemons. Grape fruits should find acceptable surroundings in some part of the coast; arrangements were being made for testing them at Winkelspruit.

Pines. — Pineapple culture in Natal is an expanding industry. Certain circumstances connected with it will probably see it take second place to the Albany district of the Cape, but given greater attention by the right kind of white man the future should be a bright one.

Some 2,500 cases were exported in 1913-14, as against 923 from the Cape, principally of the Queen variety. These carry well and open up in good order; they are lighter in colour and less full in flavour than the Albany article, but have rather a better appearance, are more uniform and have better crowns. The standard orange-box has been used for shipping them in, holding some thirty-two fruits each. Although this makes a good receptacle and an economic one as far as saving of space is concerned, it is thought that shipping in boxes to contain one dozen will pay better. This is the system adopted by Cape exporters, and their product always fetches more than does the Natal article.

Cayenne pines formed 25 per cent. of the whole export. The large size of this fruit, its delicate skin, and large moisture content, render it difficult to transport properly. It is by no means certain that it should not be carried in the cold rather than the cool chamber on board ship. Experiments are being carried out with the object of discovering the best conditions under which to handle these fruits.

Bananas.—Natal is the province in South Africa, *par excellence*, for the cultivation of the banana. Climate, soil, and other conditions are nearly all suitable; the labour engaged in the industry is nearly all Indian; and whilst that may not be in accordance with certain principles, the fact remains that the banana industry of Natal is being well handled. The demand for this fruit is so great in the other provinces of the Union that no attempt has ever been made to extend the export beyond the confines of South Africa. Some few hundred cases were disposed of annually to German East and South-West Africa and also to Portuguese East Africa. Prices, whilst not exactly high, were remunerative. There is room for some expansion and development before the needs of South Africa are fully supplied, but it is not anticipated that any export of South African bananas to Europe, at any rate for many years to come, will take place.

Mangoes and Avocados are bracketed because, though both do well enough in Natal, neither has made a success, so far, in the export market. Climatic conditions, principally atmospheric, do not appear to be conducive to good carrying of the mango, and it is only of late that the avocado has given any encouragement to exporters. With increased care in growing and packing a business in this fruit may eventually arise. It is to be feared that the same cannot be said of the mango, until such time as the tree may be planted further inland.

ENGINEERING NOTES.

National Waste of our Coal Supplies.—Professor W. A. Bone, speaking before the Society of Chemical Industry, alluded to the economical

conditions arising not only from the war, but also from the restriction of output by the ordinary process of exhaustion. He pointed out that until recently our abundant supplies of easily obtainable coal gave us a position of great advantage, but we can now no longer claim any advantage in this respect over our two nearest competitors. According to the figures issued by the International Geological Congress of 1913, the world's total probable and possible reserves of coal of all kinds within 6,000 ft. of the surface amount to 7,397,553 million metric tons, or approximately 6,000 times the present total annual consumption. Of these reserves 61 per cent. are in the United States, 16·4 per cent. in Canada, 13·5 per cent. in China, 5·7 per cent. in Germany, and only 2·6 per cent. in Great Britain. The relative insignificance of the British coal reserves is a matter of which, it seemed to him, our commercial and ruling classes are profoundly ignorant, else effective measures would have been taken long ago to check the criminal wastefulness of all classes of the community in the use of coal; and he suggested that scientific and technical societies should urge the Government to take immediate effective action in the direction of establishing through a fuel control board some systematic supervision of fuel consumption in all large industrial areas, and of promoting scientific investigation on a large scale on the better utilisation of coal. He proposed the reimposition of the duty of one shilling a ton on exported coal, a portion of the revenue so obtained to be earmarked for investigations on the problem of fuel economy. A vast amount of coal is left in the pits because colliery companies can make bigger profits by working the better classes of coal only. This pit wastage represents, on the average, about 25 per cent. of the coal actually won in the mines. The inferior grades of coal now left in the pits should be brought up and transformed at the pit-head into useful forms of energy for public purposes. He estimated that possible realisable economies in the use of coal amount to at least 30 per cent. of the total home consumption, which is now nearly 200 million tons annually. Work has been done also in this direction by the Committee of Engineers, Chemists, and Technologists appointed by the British Association under Professor Bone's chairmanship.

Power Transmission under the Sea: Cable between Sweden and Denmark. — According to *Engineering*, this scheme is now an accomplished fact and has been in satisfactory operation for several weeks. The electric energy is generated by the South Swedish Power Company at four power stations on the Lagan, having an aggregate capacity of about 19,000 kw.; but as this power is almost completely utilised, three other waterfalls on the Lagan are to be exploited, which, with sundry supplies from steam stations, will bring the total available up to about 40,000 kw. in the near future. Three-phase alternating current at 50,000 volts is used for transmitting the power from the generating stations, but for the submarine cable the pressure is reduced to 25,000 volts. The transformer station used for this purpose is at Helsingborg, and the submarine cable actually starts from Palsjo, which is situated on the coast about three miles from that town. It reaches Denmark at Marienlyst, near Elsinore, the distance under the sea being nearly three and a half miles, and is laid on the bed of the sea at a maximum depth of nearly 21 fathoms. It is made of three copper conductors with a sectional area of 0·019 sq. in. and is insulated for 35,000 volts with impregnated paper, with an external lead covering. Galvanised Z-shaped iron wires are used for strengthening it, and the outside diameter is 3·6 in., the weight being about 56 lb. per yard. The cable was supplied in nine lengths of 656 yards each, and these are connected by means of iron coupling boxes nearly 5 ft. long, which transmit the strain from the sheathing wires. The connecting boxes have inner boxes of lead which are soldered to the lead covering of the cable. At present only one of the three cables contemplated by the design has been laid, but if the experience of two or three years' working proves satisfactory, the further installation will be proceeded with. The maximum supply at present is calculated at 5,000 kw. A protecting cable of steel wire rope having a breaking strength of 40 tons has been laid to the north of the cable to guard it against damage from dragging anchors of vessels drifting south, and landmarks have been erected on both sides of the Sound to show the position of this protecting cable and warn ships not to anchor in its vicinity. There is also a telephone cable, 2 in. in diameter, insulated with guttapercha, laid beside the protecting cable.

Concrete Floors for Machinery. — Mr. Davis, H.M. Inspector of Factories for the Kent district, remarks on the causes of failure. In addition to the obvious reasons, that builders often use too much sand in proportion to the cement, and an insufficient thickness and bad foundations, there are others due to ignorance, although the intention is good. Mixtures of sand and cement expand when they are wet, and contract as they dry, and within limits the greater the proportion of cement the greater the expansion and contraction. A common practice is to put down a first layer of material with a small proportion of cement, let this dry, and then put on top of it a thin layer with a large proportion of cement. This top part thus remains a separate layer, instead of bonding with the lower part, as it would have done had it been put on at once in the unset lower portion, while, being richer in cement, it expands and contracts more than in the lower part, with the result that it may be rapidly broken up. For large surfaces, however good the work and material, the expansion and contraction are almost certain to produce cracking unless the work is divided up vertically into sections with thin strips of wood between them.

Electric Engine-starter for Industrial Motors.—The *Electrical Review* states that since the fitting of an electric engine-starting outfit on American pleasure-cars became general, there has been considerable discussion as to the advisability of adding such equipment to industrial motor vehicles. An interesting contribution to the subject has just come to hand from the United States, where the engineering department of the Reo Motor Truck Company, of Lansing, Michigan, recently carried out a series of experiments with its 15-cwt. petrol motor delivery van. It is stated that the results obtained go to show that an engine-starting outfit will more than repay its first cost in the saving of petrol effected during the first year of its use, owing to the engine being stopped instead of being allowed to run while deliveries are being made. It is also claimed that it will have a marked effect on the cost of upkeep of the vehicles, due to the elimination of the wear and tear of the large amount of idle running. Finally, it may be stated that, as a result of the test, it has been decided to adopt an electric engine-starting set as a standard part of the equipment of the Reo vehicles.

Bridge over the Neva at Petrograd.—This bridge is rapidly approaching completion. All the spans are finished, and the machinery is so far assembled that the movable central span can be worked by hand mechanism already installed. The bridge has been constructed in accordance with the plans of A. P. Pshenitsky, which were tendered at the competition announced by the municipal administration in 1908, R. F. Meltser being responsible for the architectural portion. It is a five-span structure, with a length of 246·94 metres between the shore abutments. There are eight girders in the width of the bridge, the distance between them being 3·60 metres. They are calculated to bear a load on the tramway lines of cars weighing 22 tons, and accordingly the heavier ones are placed in the middle and the lighter ones at the sides. The movable central span consists of two equal leaves. For opening it two methods are available, viz., mechanical, by means of electric motor, and hand, with the aid of a capstan. In order to enable the bridge to be opened even in a strong wind, extraordinarily powerful mechanism is required. There are eight main motors of 80 h.p. each, with four auxiliary motors of 65 h.p. and two of 10 h.p. each. The process of opening or closing the span by motor takes one minute, and by hand four minutes when there is no wind, and about eighteen minutes in a wind. The piers rest on caissons sunk with the help of compressed air into the ground to a depth varying between 23·75 and 27·86 metres. Their working chambers, after they had been immersed to the required depth, were filled first with rubble and subsequently with concrete. The width of the thoroughfare is 22 metres. The footpaths are 2·91 metres wide, their projection beyond the girders being ·25 metre. The bridge has already been opened for pedestrian traffic.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Industrial Dislocations.—The successive changes in the laws and regulations governing military service cause some modification of industrial plans. Men who were regarded as settled in their places have become liable in large numbers to serve, and the detail work in respect of their cases is a considerable tax upon managers' time. The bare task of keeping an exact record of their individual liabilities, and of complying with official forms in seeking exemptions on their behalf, is itself considerable. Then there is the business of finding or training successors, and of negotiating concerning them with the trade unions. The manufacturer feels himself to be living from hand to mouth in the matter of assistance, and his uncertainties react upon his power to enter into definite engagements of any kind. The successive changes, all bringing loss of men, are made more tolerable by the rude justice of the tribunals, which ordinarily allow certain men to be retained for a specified time upon condition that certain others are surrendered. Large numbers of temporary exemptions are falling in at the same time that the liability to serve becomes more general, and experience under these new conditions is awaited.

After the War.—It can be judged that conditions at large are not favourable to the making of individual preparations for trade after the war, but even these are not quite at a standstill. New buildings and machines are formidably dear, but there are departments in which they are being put into commission in readiness for the future. The effort will certainly be attempted to do directly with certain markets business in British goods that has been done hitherto through Germany, and the Russian market is especially in point. Rather to satisfy present than future needs headway is being made with mixed cotton and woollen yarns such as were formerly bought from Germany. Absorption in war work, and the limitations of the labour and colour supply, still tend to make current textile production less diversified than usual, and dear materials forbid any striking exhibitions of cheapness. The appointment by the Board of Trade of a Committee to consider the international position of the textile industries after the war has been passed over with less notice than so important a departure would seem to deserve. The position of the industries during the war is of absorbing interest, but it does not justify neglect of the future. As the Committee includes fifteen members associated in different capacities with the textile trades, it is constituted to understand the bearings of the problems, and presumably there will be consultations with representative bodies of traders.

The Dyestuff Manufacture.—The report of a re-combination of the German aniline dye companies is apparently well founded. The companies

had long been grouped by the exchange of capital and linked by intricate agreements controlling prices, but a firmer control will exist now that Bayer, Badische, the Berlin, Meister Lucius, Cassella, Kalle, and Weiler-ter-Meir are within a single syndicate. The new combination can scarcely lessen the objections to leaving the colour manufacture to a foreign monopoly, and it is significant that the measure should have been felt necessary. There are reports, less fully confirmed, of the purchase of a Dutch works by the German companies with the purpose of maintaining an export trade. In the United States a Bill to increase the present 30 per cent. import duty on dyestuffs has been rejected by the Senate, to the disappointment of the textile manufacturers who lent it their support. Two substantial concerns in this country have allowed it to be known that they propose to manufacture alizarine colours as soon as conditions permit. Dye—as everyone has discovered—is peculiarly essential to textile manufacture, and in bulk the cost of dyestuff is of importance. In relation to the other expenses of dyeing, the cost of the colour powder is small. The ratio varies, but in the case of a pink, costing 3½*d.* to dye, it was found that one-eighth of a penny covered the actual cost of colour. Dear colours are not so inconvenient in practice as dear steam and labour.

British Wool Resources.—Probably further attention will be directed soon to the commanding position occupied by the wools of the British Empire in the markets of the world. The leading manufacturer in the United States, fearing the introduction of an export tax upon the Imperial wools, gives their quantity as nearly two-thirds of the world's supply. Their quantitative importance is not the whole of the matter, but that aspect can be roughly illustrated by a reference to brokers' figures. There were imported into Europe and North America, in 1914, some 2,839,300 bales of Australasian and Cape wools. The River Plate and South American supply was approximately 1,160,000 bales of the same denomination. Simply on the score of quantity, the Australasian wools are highly necessary to the manufacturing trade of all countries, but in quality they are flatly irreplaceable. Wool may be likened to coal, except for the point that the supplies do not come from the Mother Country, and there are accordingly other opinions to seek before proceeding to make wool an instrument for providing the sinews of war.

Limitation of Prices.—State limitation of the prices to be paid for supplies to the Services may in some eventualities extend, but there is no cause thus far to anticipate an unreasoning attitude on the part of the authorities. They have the power to command but hardly the ability to enforce the cares of the unwilling. A spinner may be bidden to deliver yarn at a stated price, but he cannot in practice be compelled to apply the innumerable small cares that are freely exerted in keeping up to the commercial standard of excellence. A limit may be fixed to the prices of raw material, but the producer, above all when resident abroad, cannot be compelled to market his material, within that limit. Voluntary co-operation is of inestimable use in getting work done thoroughly, and the opportunities of eliciting the right spirit cannot be—and are not being—set aside. The vexed requisitioning of worsted yarn for the knitting of military underwear is in a fair way to resolve itself in a compromise. Spinners' margins will be limited to a certain excess over the cost of their raw material, but the margin, although less than that of the open market at present, will be substantially more than the minimum in other times. There will be a sacrifice, but the sacrifices will be distributed, for those owning the requisite types of machinery will each, according to his capacity, be called on to supply a proportion of the necessary yarn at the determined prices. The commands are transformed in this way into workable bargains, disadvantageous to neither side.

Industrial Starches.—The large consumption of starch in the textile industries is deemed to have had some influence in repealing the old Corn Laws. Within the last few days representations by textile traders have brought a modification of the recent prohibition upon imports of starch, dextrine, and potato flour. The consumption of farinaceous materials in binding, stiffening and smartening woven goods can be counted by the thousand tons a week, and in order to continue in the usual manner and provide a number of appreciably different "finishes," a full selection of materials is required. Flour, farina or sago in company with tallow are used in sizing the warps of cotton goods to prevent chafing in course of weaving, and by the addition of mineral ingredients the sizing mixture can be used to increase the weight of the cloth more or less considerably. Wheat, maize, rice and potato starches are employed upon cotton cloth and the manipulation of the mixtures is an art in itself. At an early stage in the war the German finishing industries were deprived of starch, and notices disclaiming responsibility for the finished results were issued to their customers. Without flour in its various forms it would be impossible to maintain the export of cotton goods, so that even that which is not eaten is in an indirect sense the food of the people. Little size is used upon wool goods, and it is more usual to apply a weak glue than a flour paste. The case was not always so, and it is recorded of a contractor in the Crimean days that he thought the troops would be able to eat his heavily starched woollens if they were unable to wear them. The incident is strictly of the past, and there is little to suggest that the fancy for stiff and heavy wool clothing is likely to return.

GENERAL NOTE.

Essays on Patriotism.—The Lundie Memorial Trust, with a view to encouraging the study of patriotism in secondary schools in the city of Liverpool, with which this educational foundation is connected, has decided to institute an essay competition which will be open to all pupils under eighteen years of age in attendance at a secondary school in the city recognised by the Board of Education as efficient. The subject of this year's essay is Robert Browning's couplet, "Here and here has England helped me; how can I help England?" The prizes offered include Lundie silver and bronze medals, with books to the total value of £2 10s. Further particulars of the competition may be obtained by forwarding a stamped (halfpenny) and directed postal wrapper to the Secretary of the Trust, Miss A. M. Davies, 27 Church Road, Waterloo, near Liverpool.

MEETING OF THE SOCIETY.

(The time given is Parliamentary, not True.)

Indian Section.

Friday afternoon, at 4.30 p.m.:—

June 23.—Sardar Daljit Singh, C.S.I., "The Sikhs."

MEETINGS FOR THE ENSUING WEEK.

Monday, June 5...Victoria Institute, Central-buildings, Westminster, S.W., 4.30 p.m. Professor E. Hull, "The Tides, with special reference to their Effects around the British Isles."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. 1. Report of the Session. 2. Messrs. R. Seligman and P. Williams, "The Action of Nitric Acid on Aluminium." 3. Professor W. B. Bottomley, "Bacterised Peat. I.—The problem in relation to Plant Nutrition."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Sir Aurel Stein, "Further Explorations in Central Asia."

Tuesday, June 6...Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Professor Pollard, "World Relations and World Organisation—The Legal Aspect."

Aeronautical Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 3 p.m. (Wilbur Wright Memorial Lecture.) Mr. G. Brewer, "The Life and Work of Wilbur Wright."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. T. M. Lowry, "Optical Research and Chemical Progress." (Lecture II.)

Anglo-Italian Literary Society, 11, Chandos-street, W., 4 p.m. Dr. R. Piccoli, "Renato Serra."

Photographic Society, 35, Russell-square, W.C., 8 p.m. Mr. D. Cameron-Swan, "Some Hints on Photographing Paintings."

Zoological Society, Regent's Park, N.W., 5.30 p.m. Discussion on the Results published in the "Biologia-Centrali-Americana," with special reference to the zoo-geographical relations between America and Africa.

Gas Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 10.30 a.m. (Annual Meeting.) 1. Address by President. 2. Dr. H. G. Colman, "Report of the Refractory Materials Research Committee." 3. "Report of the Ventilation Research Committee." 4. "Report on Thermal Phenomena in Carbonisation."

3 p.m. "Report on the Life of Gas Meters Research Committee."

Röntgen Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8.15 p.m. 1. Professor J. W. Nicholson, "Homogeneity of Visible Radiation." 2. Exhibition of X-ray and Electrotherapeutic Apparatus.

Wednesday, June 7...Geological Society, Burlington House, W., 8 p.m.

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. A. D. Heywood, "Determination of the Reichert and Polenske Figures of Butter and Margarine, using small quantities of the fat." 2. Messrs. R. R. Tatlock and R. T. Thomson, "Potash and other Mineral Fertilisers and Constituents of Plants." 3. Mr. J. Rakshit, "Estimation of Acetone in the presence of Ethyl Alcohol."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Lecture by Dr. M. A. Gerothwohl.

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Sir William M. Conway, "Goldsmiths' Work in the Dark Ages."

Thursday, June 8...Mining Engineers, Institution of, at the Geological Society, Burlington House, W., 10.45 a.m. (General Meeting.) 1. Professor F. W. Hardwick, "The History of the Safety Lamp." 2. Dr. J. S. Haldane, "The Health of Old Colliers." 3. Mr. T. F. Winmill, (a) "The Estimation of Moisture in Coal"; (b) "The Absorption of Oxygen by Coal. (Parts VIII. and IX.)"; (c) "The Oxidation of Pyrites." 4. Discussion on following papers: 1. Professor W. G. Fearnsides, "Some Effects of Earth-movement on the Coal-Measures of the Sheffield District (South Yorkshire and the Neighbouring Parts of West Yorkshire, Derbyshire, and Nottinghamshire) (Part I.)" 2. Mr. S. Mavor, "Compressed Air for Coal-cutters." 3. Mr. M. H. Mills, "Gas-producers at Collieries for obtaining Power and By-Products from Unsaleable Fuel."

Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander Mackenzie, "Chamber Music and its Revival in England." (Lecture III.)

Optical Society, at the Chemical Society, Burlington House, W., 8 p.m. Mr. F. H. Glew, "Some Technical Applications of Radium and other Luminous Substances."

Friday, June 9...Royal Institution, Albemarle-street, W., 5.30 p.m. Dr. E. Clarke, "Eyesight and the War."

Malacological Society, Burlington House, W., 8 p.m. 1. Mr. J. R. le B. Tomlin, "Note on *Erato guttula*, Low." 2. Mr. G. C. Crick, "On an Undescribed Ammonoid from the Lower Greensand (Aption) of Kent." 3. Mr. G. K. Gude, "On *Helix scytodes*."

Astronomical Society, Burlington House, 5 p.m.

Sanitary Institute, 90, Buckingham Palace-road, S.W., 10.30 a.m. Conference on Sanitary Administration under War Conditions. Mr. H. P. Boulnois and Dr. J. Wheatley, "The Maintenance of the Standard of Municipal Sanitation during the Continuance of War Conditions."

Saturday, June 10...Sanitary Institute, 90, Buckingham Palace-road, S.W., 10·30 a.m. Dr. A. B. Ritchie, "The Mental Deficiency Act from the Social and Educational Standpoint."

Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. G. Frazer, "Folk-Lore in the Old Testament." (Lecture II.)

and not scattered about. The most important necessity of all was improved agricultural education, because in his opinion more capital would be forthcoming, better organisation would be available, and better fiscal arrangements would be insisted upon when the agriculturist was better educated. Education—the right sort of education—was the crux of the matter, and he would like to have seen more attention devoted to that subject in the paper.

Sir Frederic S. P. Lely, K.C.S.I., C.I.E., expressed his sense of admiration of the silent but substantial work that had been done in India during the last few years by the Agricultural Department. Compared with earlier days, there had been an enormous advance in the manner in which the Government had dealt with the subject.

Mr. J. S. Beresford, C.I.E., said the agricultural conditions in Egypt were very much the same as in India, but there was a great difference in the results obtained and the rentals charged for the land. The difficulty in India was that the cultivator had a very small amount of capital, whereas in Egypt the farmer thought nothing of spending £2 an acre on imported artificial manures, without which the large crops grown could not be produced. He doubly recouped the expenditure by the greater yield. It was impossible for the best production from the land to be obtained without the expenditure of capital, and in any new schemes the Government of India introduced that fact must be borne in mind. It was of interest to mention that since the Agricultural Society of Egypt took in hand the purchase and distribution of artificial manure the consumption had largely increased. The import in 1909 was 21,000 tons, value £178,000; while in 1912 it had risen to 70,000 tons, value £668,000. Ninety per cent. of this was nitrate of soda. It was chiefly due to the judicious application of such manure that the high level of production in Egypt was now maintained, for the supply of nitrates from the numerous ruins in the country, on which the people formerly relied, was fast becoming exhausted.

Sir Daniel M. Hamilton, in proposing a hearty vote of thanks to Mr. MacKenna for his admirable paper, thought the last speaker had put his finger on the weak spot in Indian agriculture, viz., the want of finance on the part of the cultivator. It was impossible to build up any industry unless it had a sound system of finance at its foundation. Until the financial question was settled he was afraid Indian agriculture would not advance as rapidly as it should do. He recently read a paper by Mr. Howard calling attention to the fact that the surface soil of India, which was the best part of the soil, was being washed away. Mr. Howard advocated the erection of irrigation bunds to hold up the soil, but such work could not be carried out without money. So far as manures were concerned, he hoped a trial would be made in India of the bacterialised peat discovered by Professor Bottomley, of King's College. It had been proved to be a first-class manure, and was, he understood, being manufactured by the Manchester Corporation at £3 a ton. The Government had recently appointed a Commission to study the question of helping Indian industries. Everything possible should, of course, be done to help manufactures of every kind, but it was often forgotten that the agricultural population of India must always be the great purchasers of manufactured goods, and it therefore seemed to him that one of the ways in which the industrial development of India could best be helped was to develop her agriculture in every possible way.

Sir Frederic W. R. Fryer, K.C.S.I. (late Lieutenant-Governor of Burma), in seconding the motion, fully endorsed Sir Andrew Fraser's statement in regard to the willingness of the ryot to take up any improvement provided he could be convinced that it would pay him to do so. When he was Deputy-Commissioner of Hazara he introduced to the sugar-cane growers the iron mill made by Mr. Milne, and they adopted it in preference to their wooden mill, as it could be worked with one bullock instead of two; but they would not use the English plough because it necessitated the use of two men and two bullocks, compared with one man and one bullock with the native plough. The cultivators in India were always ready to adopt any improvements that were visible to their personal observation, and he was certain they would be only too pleased to avail themselves of the services of the Agricultural Department. That Department was evidently doing very good work, and the development of agriculture was, as Lord Curzon perceived, one of the first objects to which the Government should devote its attention.

The Chairman, before putting the motion, said that Sir Evan James's scepticism was not altogether unnatural, as cases had occurred in which the cultivators had thrown away the whole advantage they had gained from selection of seed by adulteration on a large scale. The Agricultural Department was now fully alive to that danger, and the organisation was so good that it was not likely to occur again. He also thoroughly agreed with Sir Daniel Hamilton's remark that finance was of the greatest importance to agriculture.

The resolution of thanks was then put and carried unanimously.

Sir Steyning Edgerley promised that the vote of thanks which had been so heartily passed should, in due course, be communicated to Mr. MacKenna. The suggestion was made in the paper that organised development was begun in Bombay by Mr. Mollison, but he was sure that gentleman would be the first to acknowledge the labours of a Bombay civilian, the late Mr. Edward

Ozanne. He went home to Cirencester in 1881, took his M.R.A.C., and on his return to India was appointed in 1883 the first Director of Agriculture in Bombay. Mr. Ozanne did much spade work between 1883 and 1890, and had successfully dealt with the dairy industry, the number of dairies run on scientific lines having been raised from one to about 800 by 1888, if his memory was correct. He thought it would be found that it was because of Mr. Ozanne's success that the business in Bombay outgrew his powers of dealing with it, and it became possible to convince the Government of India that there was a good case for bringing out Mr. Mollison as Superintendent of Experimental Farms in 1890. It remained only for him to express the thanks of the Committee to Sir R. Carlyle for kindly presiding that afternoon.

OBITUARY.

Sir Hay Frederick Donaldson, K.C.B.—Sir Hay Frederick Donaldson, who was drowned with Lord Kitchener in H.M.S. "Hampshire" on the 5th inst., had been a Fellow of the Society since 1889. Born in 1856, he was educated at Eton and Trinity College, Cambridge; and after serving in the shops of the London and North Western Railway Company, he was employed from 1881 to 1887 at Goa. From 1887 to 1891 he was engaged on the construction of the Manchester Ship Canal, and from 1892 to 1897 he acted as Chief Engineer to the London India Docks Joint Committee. In 1898 he was appointed Deputy Director General of Ordnance Factories, afterwards becoming Chief Mechanical Engineer, and eventually Chief Superintendent. In 1915 he became Technical Adviser to the Ministry of Munitions, and in that capacity rendered invaluable services to the country, services which were fully acknowledged a year ago by Mr. Lloyd George. He acted as President of the Institution of Mechanical Engineers in 1913, and was a member of the Council of the Institution of Civil Engineers. He received the honour of K.C.B. in 1911.

William Stanley.—Mr. William Stanley died at Great Barrington, Massachusetts, U.S.A., on May 14th last. He was a member both of the English and the American Institutions of Electrical Engineers, and had a considerable reputation as an electrical engineer in America. He was at one time Chief Engineer to the Westinghouse Electric Company, and later on he was connected with the Stanley Electric Manufacturing Company. He was the inventor of an alternating current system of long distance light and power transmission. Mr. Stanley was born in Brooklyn in 1858. He joined the Society as far back as 1887, and continued his membership for some years. In 1896 he resigned, but renewed his connection with the Society a short time back.

GENERAL NOTE.

Field Telephony.—The City and Guilds of London Institute has arranged for free courses of lectures at the Technical College, Finsbury, for officers and others, in training corps, etc., preparing for active service. The lecturer will be Mr. R. P. Howgrave-Graham, M.Inst.E.E. The college is already well equipped with apparatus for the illustration of the lectures by experiments carried out in the lecture room and in the laboratory, and a special grant for additional appliances has been made by the City and Guilds Institute for this purpose. Further courses on gunnery and gun-laying, etc., will follow if warranted by the attendance at these lectures. An inaugural lecture will be given on Wednesday, June 14th, at 7 p.m., after which convenient hours and dates for the future will be arranged. Those intending to be present are requested to send a postcard at once giving their name, military unit, and address to Lecturer, Telephone Course, City and Guilds Technical College, Finsbury, Leonard Street, City Road, E.C.

MEETING OF THE SOCIETY.

Indian Section.

June 23 (Friday), 4.30 p.m.—Sardar Daljit Singh, C.S.I., "The Sikhs."

SOCIETY'S OFFICES.

The offices will be open as usual on Monday next (Whit Monday).

MEETINGS FOR THE ENSUING WEEK.

Wednesday, June 14...Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Dr. Platt, "Notes on the Religion of Ancient Egypt."

Thursday, June 15...Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. G. Senter and S. H. Tucker, "Studies on the Walden Inversion. Part IV.—The kinetics and dissociation constant of phenylbromoacetic acid." 2. Messrs. G. Senter and H. Wood, "Reactivity of the halogens in organic compounds. Part IX.—Interaction of alkalis and alkali bromo-acetates and bromopropionates in ethyl alcoholic solution."

Historical Society, 22, Russell-square, W.C., 5 p.m.

Friday, June 16...Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Mr. G. D. West, "A Method of Measuring the Pressure of Light by Means of Thin Metal Foil." (Part II.) 2. Dr. Edith Humphrey and Mr. E. Hatschek, "The Viscosity of Suspensions of Rigid Particles at Different Rates of Shear." 3. Captain C. E. S. Phillips, "Experiments with Mercury Jet Interrupters." 4. Dr. A. Griffiths, "A Correction of some Work on Diffusion by Dr. A. Griffiths and Others."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, April 27th, 1916; SIR ROBERT W. CARLYLE, K.C.S.I., C.I.E., in the chair.

The paper read was—

SCIENTIFIC AGRICULTURE IN INDIA.

By JAMES MACKENNA, M.A., I.C.S.,

Agricultural Adviser to the Government of India, and Director of the Agricultural Research Institute, Pusa.

There is probably nothing which more clearly marks the progressive and sympathetic character of our administration of India than the fact that, at this comparatively early stage, it is possible to speak of "scientific agriculture in India." Half a century ago the subject had awakened but little general interest in England. It is true that scientific agriculture in England may historically be dated back to Sir Humphry Davy's work on the "Elements of English Agricultural Chemistry," published in 1813, while to this period also belongs the work of Boussingault in France and of Liebig in Germany. It is true also that industrial development, increase of population, the enclosure of waste land and the abolition of common land, combined with greatly advanced prices, led to a considerable improvement in agricultural practice in the eighteenth century. But although a few earnest workers like Jethro Tull, Arthur Young, and Coke of Holkham, deduced general principles and tried to influence the agriculture of the country, they were, to a large extent, only "voices crying in the wilderness." The substitution of large for small holdings led to great improvements in agricultural practice and in labour-saving machinery, and the principles of agricultural method became standardised in particular localities. It was not, however, until the beginning of the nineteenth century that scientific agriculture, properly so called, came into existence in this country.

Progress at first was slow, nor did the general economic conditions permit of much attention being paid to the results recommended. The economic upheaval during the Napoleonic wars, with an inflated currency and an extravagant increase in the standard of living, led, when peace was declared and prices fell, to a period of the greatest depression. "Man learns in suffering," and these bad years turned thoughts to schemes of improvement—schemes which a subsequent long period of unexampled prosperity—from 1831 to 1875—gave ample scope for developing. The principal lines were the investigation of mechanical appliances for agriculture, stock-breeding, and the improvement of seed.

Meanwhile agricultural chemistry was coming into its own. The work of Liebig and Boussingault was yielding results. But the greatest practical advance was made when, in 1843, Sir John Lawes established his factory for the manufacture of artificial manures. For some forty years British agriculture flourished exceedingly, and under such stimulating conditions scientific research by Lawes and Gilbert at Rothamsted and by Voelcker in London made rapid strides. It was well that full advantage had been taken of these fat years, for by 1880 British agriculture was again in a state of grievous depression. Harvests were bad, while a new economic factor, that of foreign competition, was beginning to make itself felt.

Again, the development of our colonies and the increased facilities for emigration were alluring many of our small farmers and their sons to new fields of activity.

To this period of depression and to these altered economic conditions may be attributed the awakening of a real interest in scientific agriculture. The seriousness of the position

demanded a thorough investigation of possible remedies.

Agriculture insisted that science should come to its aid as it had done to that of industries. The best of the youth of our agricultural classes were emigrating to Canada and our other colonies. They desired to take with them, in addition to what practical knowledge they had acquired, a certain amount of theoretical knowledge—for in a new country they would be thrown entirely on their own resources. Again, our colonies—largely agricultural—early realised the importance of agricultural science, and turned to the mother country for its teachers. Such were the driving forces which, towards the end of the last century, induced the development of a systematic interest in agricultural science and research. Till this driving force made itself felt scientific agriculture had not been a particularly vigorous plant in England. The work of Lawes and Gilbert was best appreciated in its practical aspect—the supply of artificial manures. In the sphere of education also not much had been done. Cirencester turned out its young squires and its land stewards. A few of the old universities had endowments which involved the delivery of a certain number of lectures annually on the principles of agriculture or rural economy, but in few, if any, was there a regulated course of study of the sciences bearing directly on agriculture; in none, except perhaps Edinburgh, was there a degree conferred in agricultural science. It is only since about the year 1900 that agricultural science and education in England have bocmed. Colleges and research stations have sprung up all over the country, and the number of young men availing themselves of the opportunities which they offer steadily increases.

It can hardly be said that in India there was any similar demand. The youth of India was not clamouring for the application of science to its greatest industry, nor did the pressure of economic conditions demand that agriculture should be thus assisted. In England the development of scientific agriculture was forced by necessity and by the clamant voice of youth anxious to get the equipment of scientific knowledge and exploit it, in most cases, far from their native land.

Scarcely had this development in England begun before we brought this gift to India—a gift the meaning of which was not, perhaps, fully realised and the immediate necessity of which was not accepted by many, including not a few of the older type of Government official, whose opinions were conservative and who thought it a vain task to teach the cultivator his own business.

But what a scope Indian agriculture offers for scientific investigation! The variations of geological formation, of climate, of rainfall, of local customs—rigid and unyielding—and the vastness of the human problem—200 million people dependent on agriculture or the industries subsidiary to it.

The varying conditions, the immensity of the problem arrest the imagination. Over vast tracts of the country the only common interest is agriculture—the monsoon, the state of the crops, the health of the cattle. It is a fortunate thing for this great agricultural Empire that a very large number of the young men who have from time to time gone out to India in one capacity or another have taken with them an interest in rural life and rural conditions.

They find themselves in their new environment in congenial surroundings. They find that the one subject which interests the people amongst whom their lot is cast is their crops and their cattle. They are brought into contact with a peasantry whose interests seldom extend beyond the limits of their fields and their simple village life.

The appeal is irresistible, and, just as England had its early enthusiasts, so these young exiles, influencing the Government under which they worked, stirred up from the beginning an agricultural policy and directed the attention of Government to the improvement of agriculture. Thus as far back as 1788 the Government of Bombay was interesting itself in the improvement of its great staple crop—cotton. For just about a hundred years persistent and continuous effort was faithfully devoted to this problem, and although it was only when scientific agriculture had been developed that any great results were obtained, the labours of these years were not in vain and some definite results were achieved. In other provinces interest in agriculture seems to have awakened at a much later date. Madras began, in 1863, by ordering from England a steam plough, some harrows and cultivators, seed drills and horse hoes, threshing machines and winnowers, chaff-cutters and water lifts. It was the material aids of Western agriculture that appealed to them.

The Government of the United Provinces, when it embarked on its Agricultural Department in 1874, struck the right note. Its object

was defined as the establishment and proof, to native agriculturists, of the advantages to be gained from small improvements such as they were able with the means at their disposal to carry out, and the making of experiments with staples and industries which it might be possible to introduce, if new, or to familiarise and improve if already existing in the country. Sir Edward Buck, the Grand Old Man of Indian agriculture—if I may be allowed to call him so —was the first Director, and his name will always be held in affectionate remembrance as the pioneer of agricultural progress in India.

Similarly, in Bengal, from 1870 Government had taken some sort of interest in agriculture, while the Central Provinces had been working away at agricultural problems from about ten years earlier.

The real awakening of an interest in scientific agriculture in India coincided with the rapid development of the subject in England. Towards the end of the last century the revival in agriculture in England was finding its reflection in India. The science was being systematised at home and was being taken more seriously. India awoke to the importance of its great industry, and took a lively interest in what was being attempted and achieved in England and on the Continent of Europe. In fact, there was evidence of a demand for the scientific investigation of Indian agricultural problems before the facilities for giving effect to it were available. But in Bombay an attempt at organised development was seriously made when Mr. Mollison, later Inspector-General of Agriculture, was in 1890 appointed Superintendent of Experimental Farms. In Madras, Mr. Benson and Dr. Barber laid the foundation of what is now a very live and progressive department.

In the Central Provinces the need for a trained staff was felt, but it was not till 1901 that a Deputy Director of Agriculture was appointed. Similarly, in the other provinces the need for systematic development was gradually making itself felt. It was not, however, till the Indian Budget of 1905-06 that Lord Curzon's Government found it possible to place the scientific study of agricultural problems on a thoroughly sound basis by the provision of funds for the creation of a Central Imperial Staff, with an adequate supply of workers and farms in each of the provinces. In this Budget an annual provision of twenty lakhs of rupees (subsequently raised to twenty-four lakhs) was made for the improvement of agriculture.

On the Imperial side Lord Curzon seized the opportunity of a generous donation of £30,000, made to him for the benefit of India by Mr. Henry Phipps, of Chicago, to establish and equip the Agricultural Research Institute at Pusa. This is now the headquarters of the Imperial Department of Agriculture in India, and, in equipment and achievement, challenges comparison with any similar institution in the East. The principal concern of the institute has, so far, been research, but post-graduate courses are also given, and, although the necessity has not yet arisen, the educational aspect has not been lost sight of, and an adequate equipment has been provided. But as provincial colleges become better established there will be an increase of students from these colleges who desire a post-graduate course, and it seems not improbable that Pusa may ultimately become the training-ground for Indian students who desire to enter the superior grades of the Indian Agricultural Service, conferring an Indian qualification ranking on a par with a British one. In my opinion, if this stage is reached, a considerable addition to the Pusa staff will be necessary, so that the time of our best research officers may not be taken up with the drudgery of formal teaching.

In the provinces the development and reorganisation of agricultural effort were also seriously taken in hand. It is unnecessary to refer to the differences of opinion which arose as to the lines on which this development should take place. Suffice it to say that there are now fully equipped agricultural colleges—in Poona for the Bombay Presidency; in Coimbatore for Madras; at Sabour for Bengal, Bihar and Orissa, and Assam; at Cawnpore for the United Provinces; at Lyallpur for the Punjab, and at Nagpur for the Central Provinces. Burma has not yet its own provincial college for agricultural education, but it is, all the same, getting its men trained satisfactorily. The staff of these colleges consists of a principal, who is generally, though not always, the agriculturist, and professors of chemistry and botany, who also do the research work of the province. Madras has in addition an entomologist and a mycologist, and to each college is attached an adequate subordinate staff. Each college has a college farm for the training of students in practical agriculture, for the demonstration of collections of the cultivated plants of the locality, and for experimental work. In most cases the botanist also has an area on the college farm for research work, and the agricultural chemist a section, on which he

conducts manurial and other experiments, and tests in the field the results of his laboratory investigations.

In most provinces there is now a Director of Agriculture as adviser to the local Government, while under him deputy directors of agriculture, each in charge of a circle, are posted at different centres throughout the province, and, aided by a staff of Indian assistants, control the experimental, demonstration and seed farms. This, in broad lines, is the constitution of a provincial Department of Agriculture.

We have seen that the benefits of scientific agriculture were brought to India almost as soon as they had begun to make their effects felt in England. But the conditions in England and in India were vastly different. In England the farmer is generally a person of education and substance, farming large areas and capable of applying the results of his reading. The great mass of the agriculturists of India are small holders, and the standard of education amongst them is, as a rule, low. There are no agricultural papers to bring to their notice new manures or new machinery; in most cases they would not have the money to purchase them, nor the experience and knowledge to make much use of them when they had got them. I am well aware that in every province of India there are not a few highly educated and intelligent landlords and farmers; but, as a rule, the cultivator of India is a small holder. This, obviously, complicates the problem. Finally, the idea of seedsmen as we know them in England, with our Suttons and Carters, is practically unknown. Till a few years ago the village Bania added this to his various lines of activity.

It might seem somewhat strange and distinctly premature to bring the conclusions of science to bear on Indian agriculture when the subject was practically in its infancy in England. But a beginning was made, and the striking results already achieved have fully justified the wisdom of the policy. The investigation of the basic principles underlying the Indian system of agriculture required careful study, and these have engaged the attention of our scientific workers since their arrival in the country, and already results of far-reaching consequence have been obtained.

But, while this recondite and abstruse investigation into first causes has been going on, attention has also been given to means of helping immediately the local agriculture and the individual cultivator. As I have already said, the professional seedsman is practically unknown in India, and the crying need for India, as for all agricultural countries, is good seed, the best seed, and plenty of it. Thus, while India is waiting for the results of patient laboratory research, there is a problem at once to hand—an easy problem, the results of solving which are immediate and quickly applicable.

When the agricultural officers arrived in India they found in nearly every crop they studied an extraordinary number of mixtures. The cultivator whose interests were limited to his village saw no harm in this; but when the demands of outside trade set a standard, the disadvantage was brought home to him and was reflected in reduced prices. The Department introduced improvement by one or more of three methods: (1) selection of existing varieties; (2) hybridisation; (3) new crops and methods. In applying the first, before any improvement could be effected, it was necessary to make a careful study of the crops and varieties of crops that actually existed. Innumerable varieties and deteriorated samples were found, and it was necessary first to determine by selection which was the best. This was done by an examination of plants growing in the field. What appeared best was selected and plants grown side by side. Their characters and out-turn were studied, and when the superiority of one or two types had been demonstrated and proved the seed was multiplied and distributed.

This is the method of improvement by selection. It is an admirable method for India, as there can be little doubt that there are already in the country numerous crops of high quality if they are grown pure to the best type. It has the additional advantage that it can at once be taken up by an officer trained in the principles of agriculture and that the results can very rapidly be brought into general practice.

Secondly, there is the improvement of plants by cross-breeding or hybridisation. This is the second great method of plant improvement, but its results naturally are slower and the technique much more scientific. It is in fact the work of the botanist rather than the agriculturist, and the application of the Mendelian methods, principally by Mr. and Mrs. Howard, Imperial Economic Botanists at Pusa, and Mr. Martin Leake, the Economic Botanist to the United Provinces Government, has already achieved wonders, notably in wheat, tobacco, and, to a less extent, in cotton. Mendelian work

is slow and requires an infinity of patience. The difficulty is to isolate plants which are an improvement—that is, which contain within themselves a large number of desirable characters. The successful Mendelian worker must have a strong power of discrimination and the courage to abandon ruthlessly what does not suit his purpose. But even in the short time which has elapsed since the work began wonderful results have been obtained by the application of these methods.

The third method is, like the first, one by which rapid progress can be made. It is the introduction of new crops or varieties and improvements in agricultural practice. Both this and the first method require only what I may call agricultural experiment as opposed to deep chemical or botanical research. They are not highly specialised methods, and can be taken up at once by the agricultural worker who is trained in the technique of his profession.

Now, what has been achieved in India under these various heads? Firstly: Improvement by selection.

One of the most important crops of India is cotton, and the fact that for years it had engaged attention in a spasmodic and unorganised way may account for its being found in a very mixed state when real scientific work upon it began. When our agricultural workers first examined the existing crops they found admixtures almost everywhere. A survey of the indigenous cottons of India was made by the Imperial Cotton Specialist, and with the aid of this the provincial officers proceeded to isolate and maintain pure types, to improve their outturn and quality by selection, and to introduce the improved plant into general cultivation.

Rapid success followed. Soon Bombay could point to a selected variety of Broach cotton which yielded 500 to 600 lb. per acre with a ginning percentage of 32·5, against 450 lb. per acre with a ginning percentage of 31·9 obtained from unselected seed. The Central Provinces have found by selection a white-flowered cotton —*Roseum*—with a high lint percentage. This has been developed, and by an admirable network of seed farms and agricultural unions, all controlled by the department, over a million and three-quarter pounds of selected seed have been produced, which sells at more than twice the price of unselected bazaar seed.

By similar methods of selection the United Provinces have established the Aligarh white-flowered cotton with a high ginning percentage, the seed of which commands a premium of from twelve annas to Re. 1-4 per maund. The efforts of the Madras Department have been so successful with pure Karunganni cotton that the seed sells at 40 per cent. above the bazaar seed. The trade, in fact, have been so impressed with the results that they have urged the department to improve by selection local varieties district by district.

The earlier work on wheat also was conducted on these lines. But the subsequent history of work on wheat in India has been so completely influenced by the application of Mendelian principles that nearly all efforts by selection have sunk into insignificance. And yet the material was to hand, in this crop as in others, if the method had been known and applied. A preliminary examination of Indian wheats by Forbes Watson had shown that India possessed wheats of excellent quality. If she had also had a staff of economic botanists who could have followed up this opinion they would have set themselves the task of selecting these superior strains and developing them. But there was no one who could undertake this obvious line of work, and attention was directed to the eradication of rust by the introduction of rust-resisting varieties from abroad rather than to the improvement of indigenous wheats by the elimination of the most liable and susceptible. Improvement of indigenous wheat had, therefore, to wait for the advent of Mendelian workers before any real progress can be recorded. This work will be referred to at some length later.

The great rice crop of Burma is being dealt with on both lines of treatment. Mendelian experiment is being called in to try and produce a product with all the qualities desiderated in the perfect grain. But this will take time, and here again some useful and more rapid results could be secured by selection. Side by side, therefore, with these deeper researches intervarietal selections are being made. Half-a-dozen varieties which already possess an established reputation among millers and cultivators—types suitable for the export market—have been selected. These have been grown and studied, plants which show marked superiority being selected and the seed grown separately. The variation in growth period, resistance to disease, standing power and uniformity of ripening will be observed. Finally, the grain-weight and straw-weight of each will be studied. As a result of this a final selection of the best varieties will be made and the seed of these selected cultures will be propagated for

distribution on a large scale and as rapidly as possible. Each selection will be given a name and number, and these, as well as its history, will finally be entered in a pedigree register. It is scarcely necessary to add that before any variety is distributed it will be thoroughly tested on a field scale.

Yet another crop to which it has been possible to apply this rapid method of improvement is jute. An elaborate survey of the races of jute in Bengal was made by Mr. R. Finlow, Fibre Expert in Bengal, and Mr. Burkill, Assistant Reporter on Economic Products.

It was found that very wide and important differences existed between *Corchorus capsularis* and *Corchorus olitorius*. Some races have a considerably taller stature, and, therefore, other things being equal, a correspondingly greater yielding power.

A suitable basis for pure line culture, as regards yielding power, was thus found, and work on these lines is being continued. At the same time, in order to secure a better fibre, a careful chemical and microscopic examination of the fibres of different races was adopted as a second basis for pure line culture. So far no single plant has been found which combines in the highest degree the two most desirable qualities—high yielding power coupled with strength and durability. Some, however, approximate to this criterion, and it is hoped ultimately to obtain what is required by hybridisation. In the meantime the seed of pure lines has been isolated. Some of these pure lines have been multiplied, and seed is now available for distribution.

A campaign of considerable magnitude has been organised for the final testing of these pure lines against local races. It is quite certain that they are amongst the heaviest—if not actually the heaviest—yielders in the province, and the tests will soon show whether they are absolutely the best or not. In any case it seems clear that in the near future the best will have been obtained, and in the meantime it is quite safe to multiply the pure lines on a very large scale, in the certainty that this seed can advantageously replace the very large amount of poor bazaar seed which is at present bought for sowing over large areas.

It is a similar method that Mr. and Mrs. Howard propose to follow in their effort to improve the indigo crop of India, but in this case it is improvement by selection of an imported variety. A few facts about this crop may be interesting. When synthetic indigo came to the front in 1897, the plant grown in Bihar was the variety known as *Indigofera Sumatrana*. This plant was a low yielder of colouring matter, and it soon became apparent that if any fight was to be made against the synthetic substitute something better would have to be found. In 1898 Mr. H. A. Baily, a Bihar planter, visited Java and, as a result of his visit, introduced into Bihar what is known as Java indigo. The cultivation caught on, and by 1910 the area under Java indigo exceeded that under the old *Sumatrana*. The plant gave a very large increase of colour, and it was thought, not unreasonably, that this crop would save the industry. Suddenly, in the monsoon of 1907, an insect pest called Psylla attacked the plant. In addition the plant wilted away, as the result, it was supposed, of some unknown disease. The out-turn was much reduced. The disease steadily became worse. Java indigo could not be induced to form seed, as the disease killed the plant before the seed set. The industry was on the verge of extinction. Work on the crop was brought to a standstill, as selection, which has formed the main item of the programme of the Bihar Planters' Association, became impracticable when seed could not be produced. Further, in view of the great decline of the industry, the association could not face any further expenditure on their Research Institute at Sirsiah, and it was decided that the investigation should be taken up by the Howards at Pusa. As the salvation of the industry was held to depend on being able to produce seed of the Java variety, this was the first problem which the Howards set themselves. This is a purely agricultural question. They have proved that indigo must be grown separately for seed and for leaf. For seed, indigo should be sown about the middle of August on high-lying and well-drained lands. The seed should be sown in lines about two feet apart, so as to promote branching and ensure abundant pollination, and thorough cultivation and cleaning of seed-beds is necessary. The soil, also, must be properly aerated. A full supply of air to the roots is essential for the production of a good crop of seed, and if grown in this way it is claimed that the so-called disease is avoided and good crops of well-grown seed obtained. The disease which ends in the wilting of the plants is really due to long-continued wetness of the soil, which destroys the young feeding roots. The theory has been put to the test at Pusa and on one of the largest estates in Bihar with good results. The next problem was the

improvement of the crop by selection. In indigo pollination by bees is the rule. There is thus extensive natural crossing in the crop, and any plant selected on account of the high indican content of the leaf is not likely to breed true, but to give rise to all kinds of offspring as regards indican content. It has also been proved that the crop, as ordinarily grown, consists of several distinct types of plant, some of which grow much more rapidly and robustly and carry far more leaves than the bulk of the crop.

The Howards propose, therefore, to take those individual plants in the mixed crop which grow rapidly and strongly, and which by their habit of growth and amount of leaf-surface are likely to give the highest yield of leaf. These will be grown separately, apart from other indigo, so as to avoid cross-fertilisation by bees. It is hoped in a short time to isolate by these means a superior type of plant with a larger yield of leaf, and probably also a large outturn of finished indigo.

From this superior type further selection will be made for wilt-resistance. Experiments on these lines will be conducted both with Java and Sumatra, as the latter will still continue to be grown as a catch-crop after rice.

To pass to the second great method of crop improvement, *i.e.* by cross-breeding or hybridisation. On these lines Mr. Martin Leake has been working for some years on cotton; but results are not yet available, though it is understood that they are full of promise.

It is in wheat, however, that the greatest achievements have been made by this method, as the result of the work of Mr. and Mrs. Howard. As I have said, Forbes Watson had indicated that India could produce wheats of first-class appearance, and that it already possessed wheats of better grade than it put on the market. The first task, therefore, which the Howards set themselves was to find out these better varieties and study their characteristics. They undertook a complete survey of Indian wheats, and separated type specimens of almost every Indian variety.

From the wheats of the Punjab twenty-five types were isolated. These, it was proved, yielded as pure types enormously increased outturns, though great variations in yield were found. They discovered, however, that these wheats were deficient in "strength," that they had weak straw, and that they did not mature early. They noticed also a great liability to rust, and in some varieties a tendency to shed their grain. All these are serious defects, and to eliminate them and obtain those qualities which are essential in a good wheat were the next problems which the Howards set themselves to study.

So far as "strength" of flour was concerned, rapid progress was made by selection from existing varieties and their propagation as pure types. For the other characteristics, such as strength of straw, experiments on Mendelian lines have been conducted and are in progress. Briefly put, this process consists in introducing into a plant by cross-breeding any quality in which it is deficient. The complexity of the problem will be recognised when it is remembered how many characters it is necessary to combine in the one wheat.

Systematic selection and comparison had to be carried out with patience and discrimination from the second to the sixth generation before the now well-known Pusa 12 wheat could be fixed as a type.

From the results already achieved there is good reason to believe that Pusa wheats, obtained either by selection and pure culture or by hybridisation, are the future wheats of India. They have satisfied the tests both of the export and local market, and have proved their capacity to adapt themselves to any environment.

It is impossible to estimate as yet the value or importance of these results to the agricultural prosperity of India, but the work of Mr. Howard and his talented wife in cross-breeding wheat can already be referred to as a great achievement, accomplished in a remarkably short space of time.

It has been calculated that a safe estimate of the gain to Indian wheat-growers, if all seed sown were of varieties like Pusa 12, would be 15 rupees per acre per year. The rate at which substitution of proved seed will take place will depend on the efficiency of provincial organisations for seed distribution. In view of the favour with which these wheats have been received and the cordial co-operation of provincial officers, it is a modest estimate to assume that in the course of a very few years the area under Pusa wheats will reach at least five million acres. This means an increase in the near future in the value of the agricultural produce of India, in one crop only, of 750 lakhs of rupees, or £5,000,000.

Mendelian principles will also play a large part in the important work on sugar-cane being carried out by Dr. Barber. The problem is a

difficult and complex one. Northern India has a predominating interest in the crop; but, on the other hand, while the area in Southern India is comparatively small, we find there much thicker and finer canes than in Northern India. But it is to the improvement of the canes grown in the great sugar tracts of Northern India that attention must specially be directed.

There are several ways in which the improvement of Indian canes may be attempted. An effort may be made to select better strains from the existing varieties at present grown. Again, canes of better quality may be introduced from countries where scientific work has been carried on for years. Lastly, the production of seedling canes, which has worked such a revolution in Java, may be tried in India also. The first two methods have succeeded in Southern India. But, as a general principle, it has been found that imported canes, all of which come from the tropics, are not suited to the sugar tract of Northern India or the prevailing methods of agriculture. The tropical thick canes, which require good cultivation and heavy manuring, are often unsuitable for lack of capital to cultivate them properly. What is wanted is a more hardy type of cane capable of holding its own with the canes grown under field conditions in Northern India. Such types are not usually available among the canes grown in tropical countries, and it is to the production of these that Dr. Barber has devoted himself. Coimbatore has been selected for the work, as it has been noted that canes there flower every year and produce pollen.

The work of the Indian sugar expert is in the main directed to the production for Northern India of superior hybrid seedlings between the local northern canes and the best southern canes. These hybrids will, it is hoped, eventually displace the inferior local varieties. The aim is to obtain such hybrids as will grow under raiyat's conditions and give a greater yield under the same treatment as is at present devoted to the crop. With such canes it is hoped that the cultivator will be enabled to improve his cultivation. At present the margin of profit on jaggery manufacture is very small, and it is improbable that there will be any permanent extension or improvement until the raiyat is provided with better hardy hybrids. The thicker canes are useless because they will not grow under the treatment they receive.

The first duty of the research station, therefore, is to produce hardy hybrids to supplant the present inferior local canes. But there is also another aspect of the work. It has been found that canes under cultivation have only a certain length of useful life, after which they have to be discarded. A batch of good new canes will only last a certain time, after which they will die out on account of deterioration and disease. Improved canes, introduced through the Samalkota farm, have disappeared in eight years. A similar fate will overtake the thick imported canes in other provinces and new hybrids. Cane-breeding must, therefore, never slacken if the wastage is to be made good, and to effect this the number of stations and workers must be increased.

Such is the work on which Dr. Barber is engaged on his own research station at Coimbatore. The seedlings and superior canes, when sufficient have been obtained, will be distributed to provinces. Dr. Barber also advises provincial officers in the survey and selection of the best indigenous varieties and on the method of propagating hybrid seedlings, and since his appointment great advance has been made in the provinces.

As our staff of botanists increases, and the more immediate problems of improvement by selection are solved, work on Mendelian lines will bulk larger and larger in the scientific work of the Agricultural Departments of India. I have merely indicated the crops on which important work on these lines has as yet been done.

It remains to consider very briefly what has been effected by the third method, *i.e.* the introduction of new crops or varieties and improvements in agricultural practice.

As regards the introduction of new crops or varieties, the establishment of ground-nut cultivation in the dry zone of Burma has saved that tract from the recurring danger of scarcity. "Dharwar American" cotton and "Cawnpore American" cotton have been established in Bombay and the United Provinces respectively. Egyptian and Upland American cotton have been introduced in Sind. We have seen that the prospect of a renewal of the indigo crop depends on the successful handling of imported Java seed. Large numbers of new fruits and vegetables have been introduced into the country.

The greatest achievement, however, in the introduction of an exotic crop is the establishment of Cambodia cotton in Madras. Seed was obtained from Pondicherry in 1904. It succeeded at once: the trade co-operated in its

development, the cotton was boomed, and within seven years the outturn had risen to 45,000 bales. The lint was better and the ginning percentage higher than that of any indigenous variety, and it could be cultivated with considerable profit on lands unsuited to Indian cotton. Valued at 180 rupees per acre, it naturally supplanted crops which only yielded some thirty rupees per acre. The large profits were a great temptation to adulteration, and this the cultivator has been unable to resist. Dealers mixed it with local cotton and tried to pass off the mixture as genuine Cambodia. Cultivators grew it on unsuitable land and the staple deteriorated. This inferior cotton was mixed with good Cambodia and palmed off on the bazaar. The crop fell under suspicion, and a premium price was no longer given. The re-establishment of Cambodia on its old footing is one of the biggest problems with which the Madras Department is confronted.

As regards improvement in agricultural practice, it seems hardly necessary to remark that this has been the concern of the Department ever since its establishment. The existing methods have first been carefully studied and improvements tried and recommended when proved. Results can hardly be set forth in detail, but one outstanding success has been the substitution of transplanting for broadcasting of rice in the Chattisgarh division of the Central Provinces. The resulting profit to the cultivators has been some 4½ lakhs of rupees per annum.

Similarly in all provinces the subject of machinery is receiving much attention, and good results have been obtained in the improvement of indigenous implements and in the introduction of European machinery. It must be clear, however, that I cannot enter into particulars as to the improvement of agricultural practice or machinery without an elaboration of details which would be tedious.

Of the purely scientific work of the Department it may be said that provincial chemists have, as a rule, confined themselves at the outset to the routine work of their farms—the analysis of soils and the experimental testing of manures—leaving to the Imperial staff the investigation of more general questions. When the routine work has made some progress they have been able to specialise on questions of importance to their provinces. Thus in the United Provinces, the Punjab, Bihar, and the Central Provinces various aspects of the chemistry of sugar have been taken up. The Burma and Madras chemists have concentrated on rice. Dr. Mann in Bombay has devoted a great amount of attention to the milk question.

At Pusa Dr. Leather has demonstrated the economical use of phosphatic manures on a large range of Indian soils. He has inquired into the water requirements of some Indian crops, and the amount of water and the period of growth during which the crop requires the principal portion of the water has been determined. The rate of evaporation of water from fallow and from cropped land and the formation and movement of nitrates in the soil are also questions which have been investigated. A considerable amount of work has also been done on the chemistry of sugar-cane and sugar-beet.

Mycology and entomology offer great fields for work in India, but the workers are few. There are in fact only three trained European mycologists in the Department, and the same number of entomologists. Even with this small band of mycologists a large amount of investigation has already been done. Potato blight, the rusts of wheat, red-rot of sugar-cane, the wilt of arhar, and the tikka disease of ground-nut are amongst a few of the diseases that have been investigated. An elaborate campaign against bud-rot disease of palms in the Godavari delta of Madras has saved roughly twenty lakhs of rupees annually. A similar campaign against a disease of areca-nuts has saved tens of thousands of rupees.

The investigation of the ufra disease of rice, which is supposed to be caused by an eel-worm, is at present one of the most important problems before the mycological staff.

Progress in mycology must be slow. In each case the disease has to be diagnosed, the cause discovered, and remedies tried and proved. It is to the credit of the handful of mycologists in India that they have already achieved so much, and that their work has led to such practical results.

It is from no lack of appreciation of the work of the entomologists that I refrain from giving details of their achievements. Such an account would be a long list of pests combated by their advice.

The first Imperial Entomologist was Mr. Maxwell-Lefroy. In the short time he was in the country he did an enormous amount of spade-work in the collection and study of the habits and life-histories of Indian insects. His "Indian Insect Pests" and "Indian Insect Life" are monuments to his industry, and he

has also left in India a number of well-trained Indian assistants. The work thus well begun has been continued by his successors; but no great impression can be made till the number of entomological workers, both European and Indian, is largely increased.

Pathological entomology has also been taken up at Pusa, and there is also a branch of agricultural bacteriology.

It will thus be seen that no branch of agricultural investigation is being neglected.

In this rapid summary of the activities of the Agricultural Departments it has, of course, been possible to select only a few of the more striking instances of achievement. But I may say that on a conservative estimate we claim that the annual increase to the value of the agricultural products of India as a result of the labours of the Agricultural Departments is already over £2,250,000. It will therefore be understood why we believe that the policy of agricultural development which established the Pusa College, and secured the scientific study in India of agricultural problems peculiarly Indian, has been fully justified.

A word on veterinary matters. Each province has a wel-equipped Veterinary Department consisting of European superintendents, deputy-superintendents, inspectors, and veterinary assistants. In some provinces the veterinary assistant is a peripatetic officer, going about from one outbreak of disease to another and applying remedies, medical or segregative. In others he has a local dispensary, from which he dispenses medicine or advice, visiting villages as necessity arises. For the training of this staff there are veterinary colleges at Bombay, Lahore, Calcutta, and Madras, and a veterinary school at Rangoon.

The research work of the Department is concentrated at the Imperial Bacteriological Laboratory at Muktesur, where are manufactured the sera and vaccines which are used to combat rinderpest, hæmorrhagic septicæmia, anthrax, and other diseases. The laboratory has a world-wide reputation, and its products are indented for from all parts of the Empire.

On the vexed question of agricultural education I would rather say nothing. First principles are still undecided, and no fixed policy has been laid down. We may struggle in time to a correct solution of the problem, but we are still struggling. I do not think that any interest could attach to an account of the indeterminate discussions of the past. I can certainly say nothing final about the subject. In these circumstances it will probably be best to adopt the policy of the old Scotch minister when confronted with a difficult point in his text: "Stare it boldly in the face and pass it by." We have the equipment; we are endeavouring to discover the best way to get material to train, and the best way to train it when obtained.

I think I have said enough to show that the Agricultural Departments of India are fully alive to their responsibilities, and that they have seriously tackled the manifold problems which face them. Their propagandist labours will be lightened and their sphere of influence extended by the vigorous parallel growth of agricultural co-operation societies—another of the great blessings we have taken to India. It is now possible to take improvements to a group of cultivators bound together by common interests instead of to isolated individuals working only for themselves.

Co-operation, by forming them into groups, gives the small cultivator all the economic advantages of the large landholders. In the harmonious union of these two great movements—scientific agriculture and co-operation—lies the economic future of India.

[In the absence of the author in India, the paper was read by Sir Steyning W. Edgerley, K.C.S.I., K.C.V.O., C.I.E., Chairman of the Indian Section Committee.]

DISCUSSION.

The Chairman (Sir Robert W. Carlyle), in opening the discussion, said the out-turn of rice in India far exceeded that of any country in the world of which we had accurate figures, it being grown over an area which was almost equal to that of Great Britain and Ireland. The production per acre, however, was not at all satisfactory. Compared with countries like Italy and Spain it was very poor, the out-turn in Spain being on the average about five times as great per acre as that in India. In the out-turn of wheat India was second to the United States and Russia, it being grown over an area greater in extent than England. The importation of Indian wheat last year played a great part in preventing an exorbitant rise of prices at a critical period. Here again the production per acre was low, it being barely one-third of the average out-turn in this country. India had the second largest out-turn of cotton in the world, taking second place to the United States. As regards sugar-cane, it headed the world. The out-turn per acre was bad, the average in India being about one ton of raw sugar per acre against four times that amount in Java and Hawaii. Thus there was a large margin for improvement in

quantity and very often in quality of the crops grown over large areas in India. It was impossible to hope that, within any reasonable number of years, the out-turn of rice or wheat per acre would approach that of Spain or England, but it was possible by scientific agriculture to obtain something very much better than the present meagre results. The author had indicated that it was expected in a few years, owing to one improvement in wheat alone, to make £5,000,000 a year more than at present. That improvement affected only one-sixth of the area under wheat, and it would bring the yield up to about one-half of what it was at present in England. The improvement of agriculture in India was, he believed, the greatest problem now before that country. The Indian agriculturist often did admirable work so far as his means allowed, and by many centuries of experience he had evolved excellent methods, but their practice could be improved by scientific application. He did not in the least underrate the importance to India of general industrial development; it was very desirable that the proportion of the population entirely dependent on the vicissitudes of the seasons should be diminished; but the main staple of India must for all time, so far as he could see, be agriculture. The development of agriculture was not only of vital importance to India from the point of view of the economic welfare of the people, but also of very great importance politically. He believed that, under Indian conditions, no political development could be altogether sound which had not at its base a prosperous peasantry capable of understanding and taking its full part in the local administration. It was very fortunate that just at the time when, under Lord Curzon's government, the Agricultural Department was put on its present lines, the great co-operative association movement was also developed. He looked to that movement to produce a profound transformation of Indian social conditions. In the ten years that had elapsed since it was first really started, 750,000 members had joined the associations, and he had seen in all parts of India the great increase in the well-being and well-living of villages where they flourished. As the author had pointed out, the two directions in which agriculture would greatly benefit by the movement were, firstly, that it enabled the Agricultural Department to deal with bodies of agriculturists instead of with single cultivators; and, secondly, it enabled the cultivator to borrow money at a rate of interest so low as to enable him to apply capital to the soil with profit. The cultivator had not, so far, availed himself of that privilege to any great extent, but he was sure that there would be rapid development in this direction, and that, owing to the influence of the associations, much more capital would be applied to the soil. India owed a great debt of gratitude to Lord Curzon for his action in regard to agriculture in India. It was very largely owing to the interest that he had taken in the matter, and to his insight into the best methods of furthering it, that the Agricultural Department owed its organisation on present lines; and it was also largely due to him that legislation was passed which made co-operative associations possible, and which provided the administrative machinery for stimulating the growth of such associations. It was also under Lord Curzon's *régime* that Sir Colin Scott-Moncrieff's committee was appointed which investigated the possibility of developing irrigation in India, and the result of its labours had been that the amount of work done since then on irrigation had enormously increased. All the time he was a Member of Council he never experienced any difficulty in getting money for any irrigation scheme which was ready. The author had shown in his paper a thorough grasp of the problems with which the Indian Agricultural Department had to deal, and he was sure the country would derive great benefit from his knowledge and capacity during his tenure of office as Agricultural Adviser.

Sir H. Evan M. James, K.C.I.E., C.S.I., thought from his experience, going back fifty years, that very great difficulty would be experienced in getting the conservative agriculturists of India to support the Agricultural Department. Fifty years ago there was a great demand for good Indian cotton in consequence of the American War, and a very distinguished Collector, without any assistance from Government, bought up all the seed which he could procure of the best variety then on the market, called Hinginghat, and forced the ryots to sow it. If any ryot sowed any of the old bad indigenous cotton his crop was pulled up. As a result, in the first year the ryots of that district benefited to an incredible extent, owing to the superior value of the new crop. At the conclusion of the American War interest in Indian cotton on the Liverpool cotton market died out, and an Act which had been passed in Bombay to prevent the adulteration and mixing of cotton was, at the instance of the Bombay merchants, repealed. As a result Indian cotton again became a byword in the market; but a fresh attempt was now being made to revive the cultivation of better staples. Unless, however, the Government of India were prepared to go further than merely introducing good staples, by insisting on their being grown and kept pure, all the very benevolent experiments referred to in the paper were, so previous experience proved, likely to prove abortive. The ryot was a very nice fellow, but he was very conservative; and although undoubtedly a good deal might be done in the way of improving Indian cotton, it was a very long and hard climb uphill to do anything really practical and permanent. Nevertheless, he wished every success to the Department.

Sir Andrew H. L. Fraser, K.C.S.I. (formerly Lieutenant-Governor of Bengal), differed entirely from the remarks made by Sir Evan James, his experience making him an optimist in regard to

the future of Indian agriculture. He believed the Indian cultivator was perfectly ready to adopt any method which was actually proved to pay, but it was necessary to show him that something was to be gained by adopting the recommendations of the Department. It was not his experience, especially in later years, that it was difficult to get the ryot to move in the right direction. He was very glad to think that the abominable heresy that an improvement in agriculture could only be obtained through the medium of large capitalist cultivators had now been dispelled. Capital was, of course, necessary; but he would rather give up hope of improvement than see the smaller cultivators swallowed up. The growth year by year of the co-operative system, which had been initiated with so much success, filled him with the greatest belief in the future of Indian agriculture.

LIEUT.-COLONEL S. H. GODFREY, C.I.E., Indian Political Department, said that Central India contained many forest tribes which took very reluctantly to agriculture, but which worked very keenly on the development of forest produce. The importance of lac was brought home to him shortly before the war. The Maharaja of Rewah started a lac factory on up-to-date lines in order to develop that very important industry in Central India, and shortly before the war Germans offered to take the whole of its output, which they mixed with cheap German alcohol and exported as varnish. When war broke out the German trade stopped, and the forest tribes were threatened with the elimination of their means of livelihood. Two small States in Central India, in order to rescue their forest tribes, started a scheme to work the factory themselves, which proved successful: and as the markets in Central India for forest produce were limited, a project was submitted to the Government of India to develop a wider ambit for the Native States which had the various forest tribes depending upon them. It was approved by the Government of India, and the Maharajas of Dattia, Panna and Chattarpur, the Rajas of Nagod and Maihar, and the Chaube-Jagirdars of the Baghelhand Political Agency formed a private limited liability company for the development of the work. Shortly after the beginning of the war, Cawnpore was suffering from the want of tannin; the Chiefs employed a scientific expert to report on their produce, and they discovered they possessed some very valuable tannins which were wanted by the Cawnpore factories for the manufacture of army equipment. The company at present deal with lac, tannin, and hides, and the Maharaja Holkar of Indore had established a factory for the manufacture of vegetable dyes for the replacement of aniline dyes. It was the first co-operative State scheme that had been started in India, and had great possibilities. The Central Indian States covered a very large area, from which it might be possible to obtain acetone by dry distillation, and tannin, the latter of which would go far towards supplying a very sore need at present in India, which had to be met by the importation of wattle bark from countries as distant as South Africa. If encouragement were given to the far-sighted and patriotic Indian Chiefs who had risked their money in the concern, it would not only benefit them and their people, but it would go a long way in the scientific development of other States. The Chief Commissioner of the Central Provinces had signified his approval of the scheme by giving to the company large tracts of forest in the northern portions of the Central Provinces on what was practically a profit-sharing basis, which seemed to show that a responsible official had some belief in the development of Central Indian forest produce on scientific lines. His Majesty's Secretary of State for India had sent a tannin expert to India and Burma with instructions to visit the Native State factory at Maihar, in Central India.

MR. A. YUSUF-ALI, I.C.S. (retired), pointed out that the apparent slowness with which agricultural improvements were introduced into India was not due so much to the unreasonable attitude of the ryots or of the people as to certain conditions which made it difficult for them to utilise those processes from which they were convinced they could make money. He was an optimist in regard to the improvement of Indian agriculture in the future, but there were four main difficulties in the way of a greater scientific application of improved methods. Firstly, the ryots had very little capital. Although agricultural co-operation had placed within their means the power of combining together and raising capital, it must be recognised that the co-operative credit movement was in its infancy, and as long as rates of interest of 9 and 12 per cent. prevailed it was impossible to speak of the salvation of agriculture in the matter of borrowing capital. The second need of the Indian agriculturist was a better organisation, not only in regard to the selection and issue of good seed, but in the selling of the produce. The ryot often received far less than his due for his produce, a larger proportion than was equitable going to the middleman. Thirdly, a more favourable fiscal arrangement was required. Many of the by-products of agriculture were not utilised because the ryot sometimes felt that he was handicapped by the Revenue Law. A great deal had been done in recent years in the Northern Provinces in the way of ensuring to the ryot the benefit of any improvements he made, but he did not have as much protection as he should do. The Zemindars were also chary in many cases of investing capital in the land, because they found that, in the periodical settlement, they did not always obtain the results which were contemplated under the Revenue Law. An improved Revenue Law in regard to the partition of land was required. Small holdings were sub-divided to such an extent that holdings of less than one acre existed. Such minute sub-division was not necessary, and it would be found in many cases that they were merely paper sub-divisions. It was necessary to insist that in Revenue partitions the holdings should be compact

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Sixty-second Annual General Meeting, for the purpose of receiving the Council's report and the Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new Fellows, will be held, in accordance with the By-Laws, on Wednesday, June 28th, at 4 p.m.

(By order of the Council),

HENRY TRUEMAN WOOD, *Secretary.*

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, May 2nd, 1916; THE RIGHT HON. VISCOUNT BRYCE, O.M., D.C.L., LL.D., F.R.S., in the chair.

THE CHAIRMAN, in introducing the reader of the paper, said it was to him a great pleasure as well as a great honour to be asked to take the chair and to introduce to the meeting his very old and valued friend, Sir William MacGregor. Sir William was one of those who had sustained the credit and shown the capacity of our countrymen far beyond the seas, and had held many of the highest and most difficult positions in the service of the Crown. The most difficult positions were not always the highest, but in Sir William's case they had often coincided. He had been in high office in Fiji, New Guinea, West Coast of Africa, Newfoundland, and finally in Queensland, having thus had experience both in the government of Crown colonies and in self-governing dominions; but wherever he had been he had acquitted himself to the immense benefit of the country and to his own high reputation. He had long thought of him as being in many respects a model Governor, because he possessed not only gifts which enabled him to represent the Crown for political purposes and to hold the balance where it was necessary to do so between rival claims and different parties in the self-governing dominions, but he also possessed a very wide and accurate scientific knowledge which had enabled him to render the greatest services to the governments of the various colonial possessions and dominions where he had been called upon to hold office. The value of the work done by Sir William MacGregor in the various colonies and dominions could not be over-estimated. The possession of scientific knowledge on the part of a Crown representative in these circumstances was rather a rare thing among our governors, excellent in other respects as they were, and anyone possessing them was able to do for these colonies or dominions many things that nobody else could do, in calling the attention of Ministers to work that could be done and giving them a line of direction which was seldom within the knowledge of a politician or even of a statesman. Sir William had been able to do that with admirable success in the many positions he had occupied with such distinction, for he combined in an eminent degree those two things, namely, a mastery of scientific knowledge and great practical tact and shrewdness.

The Secretary of the Section read the following letter received by Lord Blyth, Chairman of the Colonial Committee, from Lord Lamington, formerly Governor of Queensland:—

"I am really disappointed at being unable to be present at Sir William MacGregor's paper to-morrow. I have been with him in New Guinea, and I know happily by experience his remarkable powers and capacity not only as an administrator in dealing equitably between the influx of whites amid a native race, but also, by his knowledge of botany, astronomy and other sciences, of being able to turn to the best advantage the resources of an undeveloped country. His address should be full of interest."

The paper read was—

SOME NATIVE POTENTATES AND COLLEAGUES.

By THE RIGHT HON. SIR WILLIAM MACGREGOR, G.C.M.G., C.B., LL.D., D.Sc.

When invited to read a paper before this venerable Society my thoughts not unnaturally turned to the many men of different races with whom I have been associated, and to whom the Empire, and I as a humble individual, owe so much. It is to be feared that we are too apt, in the rush of modern life, to forget the important position such men occupy in the constitution and life of an Empire that in complexity greatly exceeds any that has hitherto existed. We overlook the fact that we are a coloured Empire; and we have been governing great areas and vast numbers of people by sending out from this country officers that, in a majority of cases, have had absolutely no training for such work. And yet we have not failed, because these officers in so many instances have had genuine sympathy with native races, and have had an innate sense of justice. One often hears it said of a native race, "Oh, they are just like children." In some ways they are, but I hope to show you that many of them are our equals, and not a few of them superior to most of us.

THAKOMBAU.

The first person of whom I have to speak is Thakombau, the greatest and best known man of the Fijian race, in many respects a very remarkable man. It may safely be said of him that no ruler, not even the first Christian emperor—whose career that of Thakombau in many points resembles—ever saw his country transformed by such enormous changes as this Fijian chief both saw and assisted in.

His grandfather, Banuvi, was the first ruling chief of Mbau of whom we really know anything. His father, Tanoa, succeeded a brother, and was constantly occupied with plunder, murder, and war, and died as he had lived, a heathen. When advised to allow the introduction of Christianity to Mbau, he replied, "You will see Christians on the island of Mbau when you see vegetables growing on my back." He little thought how his prophecy was to be realised.

Unfortunately the history of Thakombau cannot now be written, as so many of the stirring events of his picturesque life are already lost in oblivion. Here one can only have a look, in passing, at a few incidents in his career. It seems that he was born in the year of Waterloo. Soon after his birth he lost his mother, which led to his spending the first years of his life at Rewa. The first glimpse we get of him is when, as a child of six or seven, he kills a little playmate that, however, belonged to a different tribe. Then he is presented to us as the stripling Seru, living at Mbau, from which his father, Tanoa, had been driven by a rebellion. The youth was not killed nor banished, because it was thought he was too young and inexperienced to be dangerous. He was, however, clever enough to form a party that expelled the rebels, on which he brought back his father to Mbau and to power. It was from this achievement that he got the name of Thakombau, which, according to Mr. Calvert, means "Evil to Mbau"; while Mr. Royce interprets it as "Mbau is bad." He also got the name of Thikinovo, the centipede, both names having reference to his *coup d'état*. But he is best known to history as Thakombau.

In 1835 the first Methodist missionaries came from Tonga to Fiji, and two years later the Rev. Mr. Cross went to Mbau, then the centre of greatest influence in the country, but found matters so unsettled after the civil war that he did not try to remain there, but went on to Rewa.

They had just finished eating two of those chiefs that had been concerned in the expulsion of Tanoa, and two more were in the oven when Mr. Cross called at Mbau. Thakombau, however, received Mr. Cross and showed him where he could build a house; but he was not prepared to offer him protection. His pride was certainly wounded by Mr. Cross leaving Mbau and settling down in Rewa.

The white man was already well known in Fiji, but not favourably. The Rewa chief said of his own wicked brother that he had no soul, that he was like a beast, or like one of the Englishmen that came to Fiji because they would not be Christians in their own country.

In Suva, the present capital of the colony, Christianity was introduced in 1840, though that place was subject to Mbau. It was attacked by Rewa three years later, and about a hundred persons were killed, and most of them were eaten. Thakombau could not overlook this, and he went to war with Rewa. Some white men assisted Rewa—a fact that made Thakombau still more indisposed towards Europeans and missionaries. One of his brothers sided with Rewa, and in 1846 we find Thakombau obtaining permission from his father to kill this brother.

There is recorded the chagrin of Thakombau when his father accepted peace offerings from, and pardoned the people of, the village of Mathuate, which had neglected to pay the usual tribute to Mbau. In his wrath he said, "Christianity is powerful; because of it we cannot get men to eat."

His appreciation of human flesh was also shown in his reply to Captain Erskine, who had urged him to give up cannibalism: "You whites when you sail about have salt beef to eat; we have no beef, and therefore eat men."

He induced Verani of Viwa to assist him to carry out a most treacherous and cunning onslaught on Namena, when they together killed upwards of a hundred people, took their bodies to Mbau, cooked and ate them. Eighty women of Namena, wives and relatives of the dead men, were strangled. The brother of Thakombau offered the latter a present of a fine canoe to save the lives of these people; but Thakombau replied, "Keep your canoe; I want to eat men." These men had to prepare the stone ovens and to get ready the firewood to cook their own bodies. Their blood was first drawn and drunk; then their arms and legs were cut off, and their tongues cut out; then they were killed outright, cooked, and eaten. The Rev. Mr. Watsford reported in 1845 that more human beings were eaten at Mbau than perhaps anywhere else. He relates, as an example, how the Mbau people caught twenty women fishing, brought them alive to Mbau, put some of them into the ovens before they were dead, and ate the lot in one day. Sir William Des Vœux, who, as Governor, had excellent opportunities of acquiring information, was of opinion that Thakombau between the ages of six and of fifty—when he became a Christian—had eaten part of about one thousand persons.

Whilst Thakombau was continually participating in such horrors as these he saw clearly enough the merits of Christianity. He reproved those that spoke evil of the missionaries and of the Gospel they preached. When urged by the missionaries to become Christian, he asked them to be patient, to wait till he had finished his wars, then he would become Christian, and all would follow.

As a matter of fact, the Fijian, taking him all round, is the most amiable of men, and in him the religious instinct is highly developed. This characteristic, and the splendid devotion to duty of the Methodist Mission, have together produced results that are second to none in the history of evangelisation. Thakombau was no exception to the general character of his race. Even old Tanoa was at times inclined to favour the Mission. When, in 1849, fourteen women had been captured and brought to Mbau to be eaten by some visitors of distinction, Mrs. Calvert and Mrs. Lyth hurried to Mbau and rushed into Tanoa's house, which was absolutely forbidden to women, and begged that the lives of the victims should be spared. Nine had already been killed, but Tanoa spared the five still alive, and pardoned the intrusion of the heroic wives of the two devoted missionaries.

When Thakombau's father had become old, great pressure was brought to bear on the former to prevent the strangulation of a number of Tanoa's wives in accordance with custom. The missionaries offered Thakombau anything, everything they had, if he would spare the lives of the women; captains of ships of war threatened him. Thakombau, however, made no promise to bribes or menaces, but said that so great a chief as Tanoa must not die unattended, as that would be a disgrace throughout Fiji.

The Rev. Mr. Watsford as soon as he heard of Tanoa's death, in 1852, hurried to Mbau. When he arrived there one woman had already been strangled. The second, who had at one time professed Christianity, rose when called, and as she passed Tanoa's body spat on it and said: "Ah, you old wretch, I shall be in hell with you directly!" The third woman was a lady that had volunteered to be strangled in lieu of her sister. She was a proud woman, and demanded to be strangled with a new cord. Her demeanour was warmly applauded. Thakombau, who presided, was acutely distressed in the presence of the missionary, and ordered that one of the victims should live. She refused, and her own son helped Thakombau and others to strangle her. All this time Thakombau was in mental agony between pious reverence to his father and the Gospel.

The mental attitude of women with regard to strangulation under the rule of Thakombau it is not easy to understand. We constantly find a sister, the mother, or a friend volunteering as a substitute; and the proper parties frequently insist on being strangled; but that was before they had become Christian.

Shortly after the death of his father, Thakombau was formally invested with the supreme dignity of Vunivalu, "War Lord." This was his proper official title after Fiji became a British colony, but neither that designation nor his

baptismal name of Ebenezer displaced the better-known name of Thakombau.

Eighteen persons were to be eaten on the assumption by Thakombau of the title of Vunivalu, and they were brought to Mbau, some dead, some alive, for that purpose. But the Rev. Mr. Calvert prevented the eating of the bodies.

The time came, however, when things went all wrong with Thakombau. The rival Rewa became too strong for him; the whites were opposed to him, helped his enemies and cut off his supplies; he got into serious trouble with the Americans; in the eastern horizon he saw a dark danger-cloud loom up in the form of his Tongan vassals, and King George Tubou wrote to him urgently to become a Christian. Thakombau was humbled, and felt himself powerless against his enemies, but befriended by the missionaries. He sought refuge in the Christianity he had put off so long, but which he had now fully recognised to be a great power in the land.

On April 30th, 1854, he caused the death-drum—"rongorongo valu"—to be beaten to assemble the people; and in the presence of some hundreds of them avowed himself a Christian. He was baptised January 11th, 1857.

Next year Thakombau offered to cede Fiji to Queen Victoria. The offer was not then accepted.

The protection of the Crown was, however, extended to Fiji in 1874, and I was present at the Declaration of Sovereignty over that colony in June, 1875.

When I first became acquainted with Thakombau he was about sixty years of age. One could see at the first glance that there was something imposing and impressive in his face. An examination of his features revealed the fact that in him the upper eyelid just touched the circumference of the iris of remarkably expressive, bright and yet soft, eyes, which gave a look of quiet dignified command to his countenance, with an air of serene intelligence.

Captain Erskine described him as a man of magnificent physique, every inch a king.

Sir Arthur Gordon said of him the first time he saw him: "He is far more striking than the photographs represent him, very kingly in bearing, and with a most intelligent head." Lady Gordon and Lady Des Vœux described him as having the manners of a perfect gentleman.

In the unique career of this wonderful man nothing is more striking than his sterling loyalty to the British *régime*. Like the Roman Emperors up to the time of Constantine, his personality in his own estimation and in the attitude of others towards him was a sort of quasi-divinity. Yet almost as soon as the first Governor arrived Thakombau came to Levuka with some hundreds of attendants to make, without reserve and in public, his feudal submission according to the form proper for an inferior chief towards his superior. He presented to the Governor a great root of yaqona, broke off a piece, put it in the hand of the Governor, and led off the "Woh," the salutation proper to a supreme chief. The effect was electrical, and the example was followed by all Fijians ever after. When Sir William Des Vœux arrived in Fiji and drank the yaqona, Thakombau again led off the "Woh" in the same manner. Sir William put on record that Thakombau "on this, as on all other occasions up to the time of his death, seized every opportunity of showing his loyalty to the new *régime*."

Mr. Victor Williamson wrote of him that he was one of the great men of whom the world knows little; that the British Empire is indebted to him for unswerving loyalty.

Thakombau and Fiji were fortunate in their two first Governors, Sir Arthur Gordon and Sir William Des Vœux, men not only of extraordinary capacity, but also of genuine sympathy with native races. Thakombau was quick to see that, and there was very real and sincere friendship and genuine esteem between Thakombau and those representatives of the Crown. Thakombau, recognising that these men had at heart the welfare of his race, was always ready to assist them in any thing, however great, however small. I never heard the smallest approach to intrigue imputed to him, but have very many times heard the two first Governors of Fiji express their great indebtedness to Thakombau.

Personally I enjoyed, in an unusual degree, the friendship of Thakombau, who always called me "Matai ni mate," though by others I was known as "Vu ni wai." Thakombau thought the title he used to be the more applicable for surgery, in which there was a great field, and in which he took a very deep interest. One particular case made a very great impression on him, and after he had satisfied himself of the successful result, he said of it: "These whites are gods, this is making men." Like all native chiefs he was an eloquent speaker, using metaphors and similes that would rival the Iliad.

Thakombau died in 1883. The Commissioner for Native Affairs informed me that in his will Thakombau expressed the desire that I should examine his brain and write a report on it. Unfortunately, I was studying in Berlin when he died, and consequently could not comply with the wish of my old friend, and no examination of his brain was made—a distinct loss to science.

To understand the character of Thakombau, one must look at his extraordinary political sagacity in procuring allies and friends, and in isolating and destroying his enemies so as to extend his power; his firmness of purpose in carrying out his designs, in spite of bribes and threats, so long as he felt he had the power and strength to complete them; his clearness of vision and soundness of judgment in estimating his own power and the overwhelming forces arrayed against him when fortune went from him to the side of his enemies; his self-control in avowing himself a Christian in the presence of his own people, becoming before them a humble, impotent mortal, instead of being a sacred entity; and finally his unfaltering, whole-hearted loyalty to the British Crown.

Roko Tui Dreketi.

This chief was the head of a great family, which formerly ruled Rewa when it was at times as strong as Mbau. The families of Thakombau and of Roko Tui Dreketi were connected by intermarriage in the days of Tanoa and Thakombau. Roko Tui Dreketi was, as regards kingly bearing, personal appearance, and propriety, the antithesis of Thakombau or Maafu.

At the first meeting between Sir Arthur Gordon and the great chiefs at Mbau, Thakombau publicly denounced Roko Tui Dreketi as a drunkard. Yet, in spite of all his defects, this mean-looking, dissipated little man convinced me that he possessed genuine aristocratic spirit and an abundance of latent courage and fortitude.

He had a tumour about the size of a small walnut on the middle of his forehead, and this he thought disfigured him. He had asked me two or three times if I would remove it for him, and I had said I would do so whenever he was ready. I happened to be at lunch one day at Government House when the chief was there. When lunch was over we adjourned to the room of Captain Knollys, A.D.C. The *Rokotui*, when sitting in a half-reclining cane chair, turned to me and said, "Vu ni wai, when are you to remove this tumour?" I said, "Now, if you so desire." He replied, "Good, do it now." I got from my pocket-case the necessary instruments, took my place behind his seat; and laid his head back on the top of the chair, thus putting his head at a convenient height and in good light. When he saw the knife in my hand he said to me, "What about the 'sleep-water'?"—meaning chloroform. I replied, "Oh, sleep-water is for the meaner sort (Kai-si); chiefs do not require it for an operation." He replied, "That is good," and laid his head back, when I deliberately dissected out the tumour by a transverse incision so as not to mark his forehead, and sewed up the wound. He never uttered a word or a groan—never moved a muscle.

Nearly about the same time I had to open a whitlow on the toe of a powerful, fine-looking man of the common people in the hospital at Levuka. It took some half-dozen assistants to hold that man's leg for the small operation. Never before or since have I seen such a contrast, nor such a fine example of *noblesse oblige* as that furnished by Roko Tui Dreketi.

Maafu.

The Tongans as a race are not nearly so numerous as the Fijians. They were great sailors and very skilful at building canoes. Fiji contained a great deal of the finest timber for shipbuilding, and it was in connection with this industry that the Tongans frequented Fiji. They were, moreover, recklessly brave, so much so that Mara, a brother of Thakombau, declared them to be invincible, gods in fight, not human. They were of great use to the chiefs of Fiji in building war canoes, and as the sea was the special element of Mbau, the Tongans were in great repute there. It was to take delivery of a new great war canoe that King George Tubou came to Mbau in 1855, when he became involved in war and rendered important aid to Thakombau. The Tongans, though valiant and good shipbuilders, were, however, idle, in spite of the example of Thakombau and of King George, who were industrious workers in their gardens, and upheld the principle of no work no food. But what the Jutes, Saxons and Angles became to their hosts the Britons, or the Visigoths to Valens and the sons of Theodosius, that the Tongans were becoming to Thakombau and the Fijians, and this undoubtedly was one of the causes that prompted Thakombau to put himself and his country under the protection of the British Crown.

When King George returned home from Fiji

he left his relative Maafu in charge of the large number of Tongans in the eastern islands of the Fijian group. Maafu was a man of magnificent physique and of high mental endowments. Lady Gordon wrote of him that he was the handsomest man of all the chiefs. He had been a Christian from an early age, and was in all respects a man of high character, but of few words. He had a peculiar way of expressing assent to anything. I am not sure that I ever heard him say "Yes." He indicated an affirmative always by raising his eyebrows in quite a convincing manner. He ruled the eastern islands well and firmly. On my first visit to Maafu I found Ratu Timoci, the most amiable of Thakombau's sons, as his guest. He had been completely captivated by a niece of Maafu, a young lady of a figure and carriage that might have been envied by the spouse of Jove. They were married the day of my arrival. I never could learn whether this was done with the approval of Thakombau, but in any case this marriage united together the two royal families of Tonga and Fiji.

Sedu.

Sedu, a Papuan, was certainly one of the finest characters I have ever known, and his untimely fate I have never ceased to deplore.

He was the youngest brother of the chief of the Turituri tribe, who lived on the coast some thirty miles west of the Fly estuary.

He was given to me by the chief of his tribe, to wait at table, when he was about thirteen or fourteen years old. He was a gentle lad, of good manners and good temper; clever, and attentive to his duties. When he was about fifteen I had a fine example of his splendid courage and devotion to duty. I was making a traverse of a bay on the north-east coast in a boat towed by a steam launch. I had with me only Sedu and an old man from a town in the south end of the long bay, a little of whose language I understood. He was taken as interpreter. On account of bad weather my boat could not live in the sea, and about sunset we had to let the steam launch go off for shelter, while I steered our boat through the breakers and to land, going before the wind. We were surrounded by a crowd of wild and excited natives, who took possession of our heavy six-oared river boat and carried it away a considerable distance inland, so that we should not escape. Large numbers of men arrived during the night with the intention, as we were informed, of killing us next morning. With great difficulty we put up our little tent, and I went to bed in my hammock, the only time in my life that I ever lay with a revolver in my hand. About midnight a man came to me and said he wished to befriend us, and stated that if we would get up and fly with him to his town they would receive us and help us. I thought we could make a better defence where we were, and refused to start, knowing that we could so easily be clubbed or speared from behind in the dark. We got away safely in the morning, after a most interesting experience.

When we were out of danger, I said to Sedu, "Were you afraid?" His answer was, "No, sir, I was not afraid; but when that very big man shook his club over my head, I thought he would certainly kill me; but I did not care, because I knew that if he killed me you would immediately shoot him dead." According to Sedu's belief, that man, if shot as he expected, would have accompanied him to the "beyond" and been subject to him. If Sedu had shown fear, I should probably not be before you now.

When grown up he entered the armed constabulary, and was, as corporal, in charge of the six men employed as guard for Mr. Green, who was at the Mambare station, forty miles up that river, not far from the German boundary. Mr. Green was forming a new station a mile or two up an affluent of the Mamba, on a good site. One day they were all starting to work at the new place, and Sedu had the rifles of the guard put into the boat by which they were to travel. Mr. Green told Sedu that it was not necessary to take their arms. Sedu said that he had put them in the boat because the Governor's orders were very strict that they should never go out without their rifles. Mr. Green repeated his order, pointing out that they were only going to the other place, and it would be wetting the rifles unnecessarily. Sedu repeated what he said about the Governor's orders, and added that he did not like the look of the natives lately. Mr. Green said, "Sedu, are you afraid?" He replied, "No, sir, but these are my reasons." Then he received a positive order, and took the rifles back to the house, and they went without them.

When they reached the new station the men were sent out in different directions to look for building material. Mr. Green divested himself of his belt and revolver and went up to nail some rafters on the roof of the new building. A fine plantation of several acres had been made near the new quarters, and Sedu had crossed that space and was about

300 yards away when he heard the yells of two or three hundred savages who had been lying in wait for them near the new house. They all rushed for Mr. Green, and when Sedu saw him struck by a spear and fall to the ground, he turned and went straight back to die with his superior officer. Sedu was in perfect safety had he chosen to run in the opposite direction. Two or three of the other men were also killed in the bush. The bodies of Mr. Green and Sedu were cut up and thrown into the river. This took place in January 1897.

The ambuscade had been planned by the only man that had ever deserted from the armed constabulary, a Mambare man named Dumai.

We had, as soon as possible, to attack and defeat the league of tribes concerned. This was a very troublesome business, on account of the nature of the country and our exposure to fever. Several attempts were made to capture Dumai, by myself and others, but all failed till in July, 1898, I took back to the Mambare five men that had been made prisoners, and had gradually been drafted into the constabulary and been trained for about a year. One of the five had been an excellent prison warder at Samaria; another had accompanied me on many difficult journeys, and had always done good service. I appointed these men village constables on July 2nd, and told them their first duty was to capture Dumai. On the fourth one of them came to the station with some friends to deliver to me a message from the tribes of the upper Gira, that if I wished to take Dumai I had better come for him. We had already fought those people, and it was seen that they wanted to get rid of Dumai. The new village police went after him, and on July 8th brought him in irons on board the "Merrie England" steamer, at the mouth of the Mamba River. I had determined that I should not leave British New Guinea before Dumai was captured, and I had gone to the Mambare on purpose to have that completed, and it was a great satisfaction to me to leave Dumai in prison when I finished my term of ten years in that country.

I put a brass plate in the church at Port Moresby to the memory of Mr. Green and Sedu. But there remained for me an unpleasant task—to face his tribe, which it manifestly was my duty to do under such circumstances. As soon as I landed at Turituri all the men of the tribe assembled, and when we were seated in the great "man-house" a spokesman demanded to know whether it was true that Sedu, whom they had entrusted to me, had been killed.

It was evident that the position required some tact and patience. I replied that it was true that, to my great grief, Sedu had been killed, but that Sedu was still with us at Port Moresby in the spirit; and I showed them a photograph of the memorial brass tablet I had put in the church there, and told them that Sedu lives and speaks through the inscription on that brass plate to all that enter the church, and tells them to be good men and true, and to follow his example and be faithful in duty even until the death of the body. There was not another angry look in the assembly.

The Garter King of Arms was so kind as to let me have Sedu in my arms as my dexter supporter; and three years ago I sent a photograph of my arms to Sedu's tribe that they might have another proof that as long as I live I shall never forget Sedu.

Komodoa and Yakoba.

Komodoa, chief of the Polatona tribe, in Bentley Bay, and Yakoba, chief of Mita, in Milne Bay, were the two first men of note to accept and assist Government in New Guinea.

In November, 1888, on the first official visit to the north-east coast, we came on the wreck of a stranded vessel that had been recently burned. Inquiry showed that this was the remains of the "Star of Peace"; that a combination of neighbouring tribes had murdered the master, looted and burned the vessel. They had obtained a rifle, two shot-guns, and two revolvers, with a quantity of ammunition for these. This matter occupied the whole available strength of the Government for two and a half months, for it had been decided to adopt from the beginning the principle of individual, and not tribal, punishment. It was the first assertion of rule by the new administration.

That part of the country was thickly populated by tribes or communities, most of which could muster four or five score of spearmen. The two men, Komodoa and Yakoba, probably had more influence over their tribes than had any other chief in the district. Each of the two had some crude knowledge of Christianity, and were favourable to the missionary idea.

When search was made for the murderers and ringleaders the Government party came to a village called Huhuna, the chief of which was one of the principals in the attack on the ketch, and it was known that a man was there who had in his possession one of the guns and a case

of tobacco from the vessel, allotted to him for the part he took in the attack. This man was found, and the first I knew of his arrest was when Mr. Basil Thomson appeared near the beach dragging the man towards our boat by the handcuffs already on the man's wrists. How Mr. Thomson managed to get the man in irons I cannot say. The prisoner called for help, and the result was a spirited attack on us by heavy spears thrown javelin fashion. In the *mêlée* the prisoner got away, but was shot down. When we got on board our vessel in the bay, Komodoa, who was the nearest neighbour to our assailants, came on board at once to offer friendship and co-operation. But as Komodoa had kept aloof hitherto he was regarded with some suspicion. He denied all part in the attack on the vessel and her crew, and when asked why he did not join the others, his reply was, "Too much fear God." He was informed that he could prove his sincerity by capturing the principal leader in the outrage. He undertook to do so. He recovered the firearms taken from the vessel and sent them to us; and, after a delay that was beginning to look unpromising, Komodoa at last appeared at the head of a file of seventy or eighty spearmen with the man we most wanted in irons in the middle of his followers.

When the murderers were all finally dealt with, and the time came to resettle the people in their villages, the magistrate, assisted by Komodoa, could not induce them to return, and they sent messages that only if the Governor came without an armed force would they return and be at peace. Komodoa, without any hesitation, accompanied the administrator with one other man to meet and resettle several hundred men, the principal leader of whom he had captured only a few weeks previously. Although the Papuan is generally timorous, instances like this of absolute fearlessness are common enough. Komodoa remained a most faithful and devoted servant of the Government, and I deeply regretted his death when I heard of it several years afterwards. Yakoba, of Mita, was as ready as Komodoa to help us, but operations were confined to the district of Komodoa. But Yakoba had an opportunity of using the execution of one of the murderers for the propagation of his knowledge of the Gospel. He and some of his people sang hymns and spoke in favour of mission work at the execution.

The point of greatest interest in connection with those two men is that even a very rudimentary knowledge of Christianity may be of very great use in dealing with savage and hostile heathens. When the resettlement was fully discussed and the functions of the Government explained, the last request of the Chad's Bay people was that the next tribe to the north should be informed, because they said, "They kill and eat us, and we kill and eat them."

Not long after the resettlement of the natives of Chad's Bay I went there with the special object of acquiring some knowledge of their language. In this work the first necessity always is to find how to say in their tongue, "What is that?" I spent a day and a half trying to discover that phrase, and when I had failed utterly and had ordered my men to take down my tent to depart, the chief pointed to something on the ground, and I felt sure said, "What is that?" Two days after that I left with a vocabulary of some seven hundred words, quite enough for ordinary use, as you will readily believe when you remember that Paul, for example, wrote his letters to the Corinthians with 963 Greek words, and those Epistles are considered to have an unusually rich vocabulary.

Maa and Chief of Suku.

About the middle of September, 1898, when I was packing my baggage to proceed to Brisbane, an urgent message arrived from some prospectors that they had been robbed and hemmed in by a warlike tribe called Goromani, at an altitude of 9,000 or 10,000 ft. on the west end of the Owen Stanley Range. Mr. Wriford, who was known to be a courageous man, had written, September 6th, "For God's sake send me help at once . . . We were attacked yesterday, and Martin, I am afraid, mortally wounded; it is not safe to go for water... they are all about..." It was manifestly a matter of life and death. Within three days we had fitted out a party of 110 persons, of whom fifteen were armed constabulary and twenty were good conduct prisoners who were taken as carriers.

On September 22nd the party reached the village of Suku, the chief and people of which were friendly and desirous of assisting the Government. The chief and three or four of his followers joined the party without hesitation, though we were to stop at places that had been at enmity with Suku. The hardships of the carriers from Suku onwards was terrible. The track was continuously over precipitous ridges that were wet and slippery, and very dangerous to naked feet. The carriers did not grumble, for they all knew that it was a race against time to relieve the besieged party; but their trials

were so severe that many cried like children. Not a man was punished nor even reprimanded. What was needed was encouragement.

It had been intended to proceed from a village called Iritumuni direct to Goromani, to attack the tribe at home; but a native of Iritumuni gave the information that one miner had been killed at Goromani, and that he had seen Mr. Wriford's man speared and clubbed. This informant was prepared to guide us to the besieged by a direct path, that would take us to the camp two days sooner than by way of Goromani. By this track, on the thirteenth day from Port Moresby, we reached Mr. Wriford's camp with the Chief of Suku and the strongest of the armed constabulary.

I had noticed that the chief carried a new American axe, that he guarded most carefully and never used for any purpose. When asked for the reason of this he replied, "This axe is kept to be dyed in the blood of Goromani." He explained that this warlike tribe had at one time killed a number of Suku people for whom "payment" had never been taken.

On the way to the camp, from altitudes of 5,000 to 10,000 ft., and during intervals clear from fog, the village of Goromani was several times plainly visible below us, distant only a few miles. It was quite clear how it could be approached and rushed. It was found that the Goromani were holding a great feast prior to killing off the party they had plundered, and of which they had already murdered one man and severely wounded another.

Early next morning, on the way to Goromani, we passed the spot where the baggage of the miners had been pillaged, as was shown by the torn wrappings, etc.

The attacking party was able to get unseen to within 300 or 400 yards of the village, where the constabulary divested themselves of every thing save their knickerbockers, rifles and cartridge pouches. When the word was given, they, led on by Corporal Sefa, went like the wind on the village. The miners who were following on behind—they could not keep up with the constabulary—were signalled to in order that they should guard the baggage. In three or four minutes the constabulary had taken the village and the Goromani fighting men were routed and fled.

The Chief of Suku had appointed himself my bodyguard, along with my cook and some carriers, who were armed with bush knives. It was noticed that a quite new track led off the path into a place covered by tall reeds, and it was suspected that there was probably an ambuscade there. The cook, with his rifle ready, led the party into the reeds, and was confronted by the great war chief of Goromani and a few of his followers. Maa, the cook, was cleverer than the great warrior, and shot the latter before he could throw his spear, on which the Chief of Suku sprang on the Goromani man like a wild cat, and buried his fine new American axe in his skull. The others fled. The cook thus became the hero of the expedition. When the news of his exploit reached his tribe, great was their joy over the renown he had brought them. It happened that he was very much in love with a young lady of his tribe, and that the young lady reciprocated; but they were cousins, and consequently within the prohibited degrees of relationship in that tribe. They held a public meeting and decided that in this case the two young people should be made an exception, and be allowed to marry.

Koapena.

The most numerous and most powerful tribe in British New Guinea was that of Aroma, on the south coast. The best-known man in the tribe was Koapena, a tall muscular man of distinguished appearance, who maintained a great reputation by conveying to Europeans the impression that he had unbounded influence over the tribe, and to the tribe that he could obtain any favour from Europeans. He was, however, for a Papuan, hospitable, always courteous, and invariably good-humoured. The tribe, which numbered between 4,000 and 5,000, was well aware of its strength; and it was comparatively rich in coconut groves and good planting land. This people at first neither knew nor cared anything about the newly-established Government, but when they heard of its doings from time to time they did not scruple to say that the Government dare not interfere in any way with them. Many messages were sent to the Administrator warning him that he could never fight Aroma, that he would be killed before he could cross the loose sand of the dunes. They, however, ceased to make war on, or to molest, their neighbours. In June, 1893, the poet-musician of one section of the tribe had brought out a new choral dance, and another section of the tribe used it without permission. The result was civil war, and that some thirty men were wounded, one killed, and others apparently mortally wounded. The Government was obliged to take action in such a case, especially as the Administrator was in the neighbourhood at the time. A landing was made at one of

the outlying villages, and Koapena appeared as usual and admitted the trouble that had arisen, and gave the assurance that the belligerents had united against and would fight the Government were any arrest attempted. The position was serious, as only a score of the armed constabulary was available at the time, and these were all recent recruits speaking different dialects and not half trained.

A visit was made to the principal village, though this was not without risk, and the people solemnly warned that they must surrender the ringleaders or the Government would attack the village and take them by force. The small detachment was made as safe from attack as possible, and left where landed.

A river ran up-country between Aroma and the spurs of the mountains at some distance behind, the mouth of the river being some miles from Aroma. It was cleared and ascended by using dynamite and American axes, and the clearing party were welcomed by the hereditary enemies of Aroma. On the return of the Administrator, Koapena admitted that this isolation and the attitude of their former foes had caused a division in the tribe, as many had become seriously alarmed. The final result was that the tribe yielded to continuous pressure, that they surrendered three of the four ringleaders, that six village constables were appointed and duly installed. One of the three surrendered men escaped, but the new constables remained loyal, arrested him promptly, and handed him over; and the fourth one who had fled was arrested by them later on and brought to Port Moresby. After the appointment of their police the only man that showed a tendency to disloyalty was Koapena himself, who, like the Hereditary Boiler of Human Heads in the tribe, saw that his own position was lessened in importance. Koapena was too clever a man not to see that he must adapt himself to the new order of things, which had brought the whole tribe completely under Government control, to which Koapena had, indeed, though unconsciously, contributed.

This was the greatest achievement of the Government during the first ten years of its existence. On several prior occasions, where hostile tribes had been brought under control by the exercise of violence, the Administrator had received congratulations from his superiors, but of this case no notice was taken by the Secretary of State or by the Colonial Governments concerned. It would have been different had there been bloodshed.

Some time later on an amusing incident occurred with Koapena. I called at Aroma when Sir Samuel Griffith was my guest. Koapena was in mourning for some relation he had lost, as shown by his face being covered by a thick layer of lamp-black. The method of polite salutation there then was to rub noses. I learned afterwards that there was much discussion as to whether Sir Samuel would rub noses with Koapena under such circumstances. To the surprise of the onlookers Sir Samuel never hesitated a moment, but rubbed noses with Koapena as heartily as if he had been the chief's brother, or as if the salute were to leave no trace behind. It certainly was a remarkable sight, and it contained a great lesson, to see this distinguished scholar, jurist, and statesman, who had indeed been the principal in establishing a government there, rub noses with such a barbarian as Koapena. Naturally, Koapena and his people were greatly pleased.

The succession to the chieftainship in that tribe is from chief to nephew, so that probably Koapena's brother's son is now chief of Aroma.

John Allan, an Australian Aboriginal.

John Allan, of Mundoolan, a man of nearly sixty years of age, is the last of the Wangerriburra tribe. He lives on the estate of Mundoolan near the south coast of Queensland. He has been educated to read and write. He speaks English well, and is in every respect, save in colour and feature, a white man. He is employed about the homestead, and is treated just as if he were a European. He is the only living aboriginal of the Beaudesert district. I became interested in this man, and in the language and customs of his tribe. A competent officer was provided with the standard directions for writing aboriginal dialects, and was sent to secure a large vocabulary of the Wangerriburra tribe, which, but for this man, would have been lost for ever. It was published in the Report for 1914 of the Chief Protector of Aboriginals of Queensland.

It appears that in this country the intelligence of the Australian aboriginal is greatly underrated. As a matter of fact, they are very brave, ingenious, dexterous, and capable of enduring great fatigue. They probably represent the oldest race of men of which we have any knowledge. What seems perplexing is the fact that they were unable spontaneously to make any advance along our lines of civilisation. I have met a considerable number of them that, up country, earn good wages as stockmen. It is greatly to be deplored

that they are fast hastening towards extinction, for they would have been of the greatest use as station hands. One example of their inventiveness will suffice. Away in the north-west of Queensland a tribe prepared a corroborree for my benefit. I found the young men covered over by the feathers of the white cockatoo. It was ascertained that they had bled several men by opening a vein of the arm to obtain blood with which to glue the feathers to their bodies. A month or two later I read in a German paper an article on the new use of bullocks' blood in glueing on veneer in cabinet-making in Germany. I am sure the aboriginal did not learn this use of blood from the German.

The Alake of Abeokuta.

The most distinguished and most enlightened chief in the Protectorate of Lagos in my day was the Alake of Abeokuta. Ake is the name of the dominant quarter of the town of Abeokuta, the capital of the Alake's province, and his title may be paraphrased as "Lord of Ake." He estimated his total population at 350,000; that of his capital is over 50,000.

The Alake is of a hereditary ruling family, one of the chiefs that have the right to wear a crown and other regalia. The divinity that doth hedge a king is still in full vigour among those very conservative peoples. Even the Oni of Ife, whose ancestors were the heads of the Yoruba race, could not add to the number of crowned heads, from fear of the fetish. Indeed, when the Oni visited me in Lagos, where a great Council was held to determine the question whether a certain chief who had assumed royal ensigns could do so legitimately, he had to sacrifice five sheep to his own crown between Ife and Ibadan, a two days' journey on foot.

The Alake's province enjoyed many attributes of self-government under treaties with Great Britain, and the Alake and his people had made greater advances in the development and settlement of their country than any other native administration on the west coast. He ruled his province with vigour, and was conscientious in dealing with the public money of his people, some £12,000 to £15,000 a year. When I complained to the Alake that his people were stealing the fine wedges of soft steel used in fixing the rails in the metal sleepers of the railway, and explained that this might cause disastrous accidents, he promptly passed a law to make this a capital offence. Not another wedge was stolen.

He and his people were given to agriculture, road-making, house-building, and trading. He took up cotton-growing and sanitation, regulated police and prisons, and had a high regard for education. The Alake and his council possessed judicial as well as legislative and executive functions. But my last official act there was to put through an arrangement to bring indictable offences committed in the Abeokuta province under the cognisance of the Supreme Court of Lagos.

The Alake came to this country in 1904, to give effect to two wishes he had for some years entertained: to be presented to the Sovereign, and to learn here what he could that might be useful to his own people. He insisted on coming to England while I was here, in the hope that I might help him. He was most industrious while here. At one agricultural show he ploughed land, but he had difficulty in believing that he was not required to push the plough. At the same place he fearlessly entered a gauze-wire net enclosure where there were several swarms of bees, and handled them like the immune keeper. He hauled a net at salmon fishings; and he made some blocks for street pavement from granite similar in colour and texture to the rocks on which his own capital stands.

But the delight of the Alake's life was in his being presented to King Edward at Buckingham Palace.

His Majesty, seated on the throne and with the Secretary of State and other great officers on the steps, received the Alake in state. The Chief wore his native regal robes. When he advanced to about three yards from the throne he knelt on the floor and touched the carpet three times with his forehead.

His Majesty, in a brief but admirable speech of encouragement and approval, addressed the Alake; and the chief made an excellent loyal and dutiful reply, expressed in picturesque language.

You have all heard of, and many of you must have seen, the fine engraving of Queen Victoria presenting a Bible to an African chief, as "the secret of England's greatness." The African chief in question was the father of the Alake. Through the kindness of Henry Graves & Co., Pall Mall, we have been able to put on the wall a copy of that engraving.

The Alake mentioned in his brief speech how Queen Victoria, His Majesty's Royal Mother, had presented a Bible to his (the chief's) father, and how that gift had been treasured by the recipient and his people. When the ceremony

was over, I asked the Alake how it was that during my many visits to Abeokuta they had never mentioned, nor shown me, that Bible. Then it came out that when the King of Dahomey with his women regiments invaded Abeokuta and burned part of the town, the Bible perished in the flames.

When, a few days later, I was relating this to the late Hon. Maude Stanley, that lady said, "Why do you not ask the King to give a Bible now to the Alake?" I replied to the effect that I had reserved that for Miss Maude Stanley, to which the answer was, "All right, get me the particulars."

I had already got into a railway carriage which the Midland Railway had put at the service of the Alake to convey him to Liverpool on his return to Africa, when a Royal messenger handed me a parcel with a letter, which ran as follows:—

"General Sir Dighton Probyn, Keeper of the Privy Purse, presents his compliments to Sir William MacGregor, and sends him, by command of the King, the accompanying Bible, which His Majesty requests Sir William will be good enough to give to the Alake of Abeokuta as a present from His Majesty, to replace the Bible given to the Alake's father by Queen Victoria, and which was destroyed in a fire some twenty years ago.—July 7th, 1904."

The Bible was duly presented to the Alake at Liverpool as commanded by the King. The Alake himself was very broad-minded in matters of religion, and would go in one forenoon to several religious services, of different Christian sects, and would look in on Mohammedan or Shango meetings on the way home. When I last saw him he had not made up his mind as to which Church he would join.

It was thought by some people that the notice taken of the Alake in this country would spoil him; but I never heard that he had lost his equilibrium by it.

DISCUSSION.

The CHAIRMAN (Viscount Bryce) said it was entirely superfluous for Sir William MacGregor to apologise for the length of his paper, because he was sure they would all have been pleased to listen to him if he had gone on for an hour or two longer. They had been told many interesting and instructive things that enlarged their ideas about those whom they were in the habit of calling barbarous or savage peoples. What Sir William had said was quite true, as anyone who had studied a little of the history of these semi-civilised and barbarous people knew. There were many very remarkable and striking characters who from time to time appeared among these peoples, who achieved great things and left fame behind them for generations. He would like to be permitted to give two or three examples. There was a great chief in Hawaii who was seen as a very young man by Captain Cook, and who lived to be, first of all, conqueror of his own island, and subsequently, by his many successful expeditions, the conqueror of the rest of the Hawaiian Archipelago. His name was Kamehameha, and he was the founder of a dynasty which ruled over the Hawaiian Islands until they fell into the hands of the United States thirty years ago. Another such was Moshesh, a famous chief of the Basutos, in South Africa, who ultimately, like Thakombau, gave his country over to our direction, since which the Basutos had lived happily and thrived wonderfully under our government. Another such man (unless he was mistaken) was Khama, who still holds dominion over a large territory in Bechuanaland. These were a few cases similar to those mentioned by Sir William MacGregor, and it was very interesting to have such studies of their character as had been given in the paper. There was a great deal in the paper which they would all remember with pleasure, and when they had all of it, with the parts which had been omitted for want of time, before them they would all undoubtedly return to it in order to read what Sir William had been obliged that afternoon to omit. In conclusion, Lord Bryce read a letter from the Prime Minister of Queensland, the Hon. T. J. Ryan, regretting his inability to accept the Society's invitation to attend the meeting. Mr. Ryan added: "No one is better qualified to speak upon the subject he (Sir W. MacGregor) has chosen. His fame as a pro-consul is universal, but we in Australia have had a special opportunity for appreciating his great work. Amongst the natives of New Guinea, although many years have passed since his Governorship of that dependency, his name is still held in almost supernatural regard."

MAJOR SIR THOMAS B. ROBINSON, K.C.M.G., Agent-General for Queensland, in proposing a vote of thanks to Sir William MacGregor, said they had all enjoyed listening to the many interesting things he had told them. In Queensland they had had long experience of Sir William, they knew the great work he had accomplished for the Empire, and they were all exceedingly sorry when it became necessary for him to leave the colony.

SIR ARUNDEL T. ARUNDEL, K.C.S.I., in seconding the resolution, said Sir William MacGregor had given them a most interesting account, with wonderful descriptive sketches, of what to him (the speaker) was an entirely

new world. He had been very much struck by the extraordinary tact Sir William had shown in all kinds of difficult situations—situations from which he had emerged in a manner that was not only creditable to himself, but of great advantage to the Government he served. Lord Bryce had referred to Sir William's scientific knowledge, and to the few cases in which such knowledge was possessed by our administrators in distant parts of the Empire. He had been making a mental calculation of how many Governors he had known in India, and thought he could number fourteen; but he did not think one of them had any acquaintance with science in the way that Sir William MacGregor had. In those days probably the difficulty of acquiring such knowledge was very great, but in future it would be less so.

The Hon. J. G. Jenkins, in supporting the motion, said it was now twenty years since Sir William met several of them who were Ministers of the Crown in South Australia, and gave them a most graphic description of British New Guinea. He had met him since on several occasions and had visited both Fiji and New Guinea. It was difficult to measure the value of the work done by Sir William in New Guinea. For ten years he was there in the midst of a population of many hundreds of thousands of blacks, and the great majority of them, especially on the western side of the island, were cannibals. Yet he brought these islanders practically into a state of civilisation, so that, with the exception of the extreme west, it was now possible to travel in every part of New Guinea in perfect safety. One of the causes of this great change was his treatment of prisoners, who had committed crimes without knowing they were crimes, and which had been the ordinary practices for centuries. When in New Guinea he (the speaker) visited places miles and miles away from any white settlers, where the only persons in charge were the jailor or prison superintendent and some prisoners. He found the prisoners perfectly safe—indeed, to such a state had discipline been brought that they were told that if they did not come in from their work at night they would be locked out! The immediate successors of Sir William had followed the lines laid down by him, and it was doubtful whether anywhere else in the world had such a large number of natives been brought, in so short a space of time, to the realisation of civilisation, especially remembering that the inhabitants of New Guinea were not possessed of the intelligence which characterised, for example, the Maoris of New Zealand.

The resolution was put to the meeting and carried unanimously.

Sir William MacGregor, in replying, expressed his appreciation of the references that had been made to himself, and regretted that his services did not deserve the encomiums they had received. He considered it a great honour to have Lord Bryce in the chair, and mentioned that as Chancellor of the University of Queensland he had enjoyed the signal pleasure of conferring on his lordship what he believed was his twenty-fourth or twenty-fifth university degree. He added that such distinctions were not granted by universities without due cause. He himself had been surprised and delighted by the extraordinary range of knowledge possessed by Lord Bryce, which covered botany, astronomy, geology, literature, etc.; but this was only telling them less than half, as they would gather from the fact that he (Sir William) was informed by the Attorney-General of a former Government that there is nothing worth knowing in international law with which Viscountess Bryce is not acquainted. He expressed his sincere thanks to the audience for their attendance and attention, and apologised for the fact that in the paper there was too much of the first personal pronoun.

THE SOCIETY'S PREMISES IN 1760.

An interesting confirmation of the information about the premises "Opposite Beaufort Buildings," given in the History of the Society, is provided by an old plan, lately discovered in the office of the Bedford Estate. The property east of Southampton Street, between the Strand and Tavistock Street, at one time belonged to the Dukes of Bedford, but was sold by them, and the plans and documents relating to it have therefore not for the most part been preserved. There are, however, still certain plans in existence, and it was from one of these that the plan given on page 56 of the History was compiled. Some of the details, however, were rather conjectural, but these are now confirmed by the newly found plan, which shows the precise area occupied by the Society's premises. It is marked as "On lease to John Price, in the Occupation of the Society of Arts and Sciences and others." Price was the original lessee, and he demised the property to Williams and Woodin, by whom it was let to the Society of Arts. The dimensions of the "Great Room" and the other buildings are set out, and correspond with those given in the History. There is indeed no fresh information provided, but it is very satisfactory to find the previous researches so fully confirmed. The Society is again indebted to Mr. Stutfield, the steward of the Bedford Estate, and to his colleague Mr. Marchant, for the kind thought which led them, on the finding of the old plan, at once to show it to the Secretary of the Society, and to permit him to have a copy made of it. The date of the plan is not known, but it must have been some time between 1760 and 1774.

OBITUARY.

Elmer Lawrence Corthell, D.Sc. — Mr. Corthell, the well-known American civil engineer, died on May 16th. At the time of his death he was actually President of the American Society of Civil Engineers. He was born in 1840, and commenced his professional career in 1867. He carried out a large number of important engineering constructions in the United States, including many large bridges, and carried out much important railway and canal work. He was associated with Captain James B. Eads in the improvement of the Mississippi navigation. He also took part with the same distinguished engineer in the project for the Tehuantepec Ship Railway. This scheme, jointly devised by Captain Eads and Mr. Corthell, was never carried out. He also carried out important works in Mexico, amongst others the improvement of the harbour of Tampico. He was a prominent figure in engineering circles in this country, and on the European continent, as well as in the States, for he acted as American representative on various Congresses and Conferences.

Mr. Corthell joined the Royal Society of Arts in 1891, and took much interest in its concerns—indeed, until a very recent time he was in constant correspondence with the Secretary. It may be mentioned that he took a good deal of trouble in obtaining a complete set of the Society's *Journal* for presentation to his old university—the Brown University of Providence, Rhode Island—of which he was a D.Sc.

GENERAL NOTES.

School of Oriental Studies.—It is announced that a Charter of Incorporation has been granted to the School of Oriental Studies, into which the London Institution has been converted, and that the Governing Body has been constituted. The charter states that the purpose of the school, which is to be an institution of the University of London, is to give instruction "in the languages of Eastern and African peoples, ancient and modern, and in the literature, history, religion, and customs of these peoples, especially with a view to the needs of persons about to proceed to the East or to Africa for the pursuit of study and research, commerce, or a profession." It is understood that the first meeting of the Governing Body will be held before the close of this month, and it is hoped that the school will be started in the autumn.

The Truffles of Perigord and Sarladais.—The districts of Perigord (Department of Dordogne) and Sarladais are famous for their truffles. These highly-prized fungi make their appearance during the first days of August, and are gathered from then to the end of March. They are found under a variety of oak called the truffle oak (*chêne truffier*), also near the evergreen oak (*chêne vert*), and the hazelnut tree (*noisetier*). Those who make a speciality of gathering truffles are called "caveurs de truffes." They search for them with trained dogs or pigs, the animal locating the hidden truffle by scent. The truffles are gathered every day or two and carried by the "caveur" to the nearest market town, where he sells them to commission merchants, who buy for the large dealers. The normal price for truffles is 5 francs per kilogramme (about 4*s*. per lb.), but sometimes the "caveur" receives as much as 12 and 15 francs (9*s*. 6*d*. and 12*s*. per lb.). The first-of-the-season truffles are called "truffes à la marque," and are inferior in quality to those gathered later. "Truffes à la marque" are black outside and white inside, and have little or no fragrance. With the appearance of cold weather, says the United States Vice-Consul at Limoges, the truffles improve in quality and acquire a greater fragrance. The fine-quality truffle is black outside, black and grey grained inside (*noire marbrée*). The truffles grown in Perigord and Sarladais possess the most fragrance, and are generally superior to those grown in other sections of France. In 1913—the latest year for which detailed statistics are available—France exported 451,500 lb. of fresh, dried, and pickled truffles, 21,600 lb. of which went to the United States. These shipments had an average value of about 5*s*. 6*d*. per lb.

MEETING OF THE SOCIETY.

Indian Section.

June 29, 4.30 p.m.—Sirdar Daljit Singh, C.S.I., Member of the Council of the Secretary of State for India, "The Sikhs." The Right Hon. Austen Chamberlain, M.P., Secretary of State for India, will preside.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 19...London Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. Mr. A. Crow, "The Port of London."

East India Association, at the Institution of Civil Engineers, Great George-street, S.W., 4 p.m. Mr. H. Kelway-Bamber, "Thirty-five Years' Advance in Indian Railway Development."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Mr. A. E. Kitson, "The Gold Coast: Some Considerations of its Structure, Peoples, and Natural History."

Tuesday, June 20...Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m.

Colonial Institute, Hotel Cecil, Strand, W.C., 8.30 p.m. Sir Lionel Phillips, Bt., "South Africa and the Empire Problem."

Wednesday, June 21...Meteorological Society, 70, Victoria-street, S.W., 4.30 p.m. 1. Messrs. J. E. Clark and H. B. Adames, "Report on the Phenological Observations for 1915." 2. Messrs. M. Christy and W. Marriott, "Audibility of the Gun-Firing in Flanders over the South-East of England, September 1914—April 1916." 3. Lieut. E. H. Chapman, "The Relation between Atmospheric Pressure and Rainfall at a Single Station."

African Society, Hotel Cecil, Strand, W.C., 7.30 p.m. Mr. P. A. Talbot, "Ibo Customs and Beliefs of Yesterday."

Microscopical Society, 20, Hanover-square, W., 8 p.m. Miss G. Lister, "A Sketch of the Life History of the Mycetozoa, with special reference to Ceratiomyxa."

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Journal of the Royal Society of Arts.

No. 3,318. VOL. LXIV.

FRIDAY, JUNE 23, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

FINANCIAL STATEMENT FOR 1915-16.

The following statement is published in this week's *Journal* in accordance with Sec. 40 of the Society's By-laws :—

TREASURERS' STATEMENT OF RECEIPTS AND PAYMENTS FOR THE YEAR ENDING MAY 31st, 1916.

Dr.

	£	s.	d.	£	s.	d.
To Cash in hands of Messrs. Coutts & Co., May 31st, 1915				2,737	15	5
,, Subscriptions	4,111	14	0			
,, Life compositions	515	8	0			
				4,627	2	0
,, Dividends and Interest				572	8	10
,, Ground Rents				592	18	8
,, Examination Fees				2,796	0	0
,, Advertisements				132	1	6
,, Sales, etc.:—						
Cantor Lectures	4	13	1			
Examination Programmes and Advertisements	90	14	5			
Fees for use of meeting-rooms	62	9	6			
Journal	130	1	8			
Leather Committee Reports ...	0	8	11			
History of the Society	17	19	6			
				306	7	1
,, Donation to Examination Prize Fund :— Clothworkers' Company				40	0	0
,, Donation from Reginald Le Neve Foster for a Prize				40	0	0
				£11,844	13	6

Cr.

	£	s.	d.	£	s.	d.
By House :—						
Rent, Rates, and Taxes	853	8	2			
Insurance, Gas, Coal, House expenses, and charges incidental to meetings	318	5	7			
Repairs and Alterations	34	4	0			
				1,205	17	9
,, Office :—						
Salaries and wages	2,590	19	0			
Stationery, Office Printing and Lithography	249	5	4			
Advertising	34	2	6			
Postage Stamps, Messengers' Fares, and Parcels	183	0	11			
				3,057	7	9
,, Library, Bookbinding, etc.				72	10	6
,, *Journal*, including Printing and Publishing				1,569	0	2
,, Advertisements (Agents and Printing)				108	17	2
,, Examinations				3,831	9	2
,, Medals :—						
Albert	20	15	6			
Society's	21	15	0			
				42	10	6
,, Owen Jones Prizes				11	5	0
,, North London Trust				5	0	0
,, Fothergill Lectures				90	0	0
,, Le Neve Foster Prize				11	19	6
,, Juvenile Lectures				17	11	6
,, Cantor Lectures				91	1	6
,, Sections :—						
Colonial	47	4	4			
Indian	68	18	6			
				116	2	10
,, Committees (General Expenses)				20	2	0
,, Investment of Le Neve Foster Donation in £40 War Loan				39	15	8
				10,290	11	0
,, Cash on Current Account with Messrs. Coutts & Co., May 31st, 1916 (less cash in transit)				1,554	2	6
				£11,844	13	6

Liabilities.

	£	s.	d.	£	s.	d.
To Sundry Creditors	639	18	1			
,, Examiners' Fees	1,092	13	6			
,, Examination Medals	50	0	0			
,, Sections :—Colonial and Indian	100	0	0			
,, Accumulations under Trusts	281	3	0			
				2,163	14	7
,, Excess of assets over liabilities				21,579	19	6
				£23,743	14	1

Assets.

By Society's Accumulated Funds invested as follows:	Amount of Stock, etc. £	s.	d.	Estimated Value on May 31st, 1916. £	s.	d.	£	s.	d.
Newcastle-on-Tyne 3½ per Cent. Stock	3,000	0	0	2,880	0	0			
Canada 3½ per Cent. Stock	500	0	0	368	15	0			
South Australia 4 per Cent. Stock	500	0	0	412	10	0			
N.S. Wales 3½ per Cent. Stock	530	10	1	464	17	0			
N.S. Wales 4 per Cent. Stock	500	0	0	415	0	0			
G. Indian Pen. Ry. 4 per Cent. Debenture Stock	217	0	0	201	16	2			
Queensland 4 per Cent. Stock	100	0	0	92	5	0			
Natal 4 per Cent. Stock	500	0	0	410	0	0			
Ground-rents (amount invested)	10,496	2	9	10,496	2	9			
Metropolitan Water Board B. Stock	321	15	9	239	14	8			
New River Co. shares	6	0	0	6	0	0			
India 3½ per Cent. Stock	3,408	14	6	2,752	11	0			
	20,080	3	1				18,739	11	7
,, Subscriptions of the year uncollected				690	0	0			
,, Arrears, estimated as recoverable				270	0	0			
							960	0	0
,, Property of the Society (Books, Pictures, etc.)							2,000	0	0
,, Advertisements due							90	0	0
,, Cash on Current Account and on Deposit with Messrs. Coutts & Co., May 31st, 1916 (less cash in transit)							1,554	2	6
,, Do. on Deposit (against interest on Trusts)							400	0	0
							£23,743	14	1

Funds held in Trust by the Society.

	£	s.	d.	
Dr. Swiney's Bequest	£4,477	10	0	Ground-rents, chargeable with a sum of £200 once in five years.
John Stock Trust	66	13	4	4½ per Cent. War Stock, chargeable with the Award of a Medal.
Benjamin Shaw Trust for Industrial Hygiene	88	17	10	,, ,, ,, of Interest as a Money Prize.
North London Exhibition Trust	128	1	4	,, ,, ,, ,,
Fothergill Trust	258	14	2	,, ,, ,, of a Medal.
J. Murray and others, in aid of a Building Fund	57	8	4	,, £36 12s. 0d. and India 3½ per Cent. Stock £20 16s. 4d.
Subscriptions to an Endowment Fund	374	14	10	,,
Dr. Aldred's Bequest	146	14	10	,, chargeable with the Award of a Prize.
Thomas Howard's Bequest	571	0	0	Metropolitan Railway 3½ per Cent. Preference Stock, chargeable with the Award of a Prize.
Dr. Cantor's Bequest	648	19	7	Bombay and Baroda Railway Guaranteed 3 per Cent. Stock } Interest applied to the Cantor Lectures.
	3,273	16	6	India 3 per Cent. Stock
	2,695	11	3	Ground-rents
Owen Jones Memorial Trust	522	3	2	India 3 per Cent. Stock, chargeable with the Award of Prizes to Art Students.
Mulready Trust	105	16	0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
Alfred Davis's Bequest	1,953	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
Francis Cobb Fund	255	14	1	New South Wales 3½ per Cent. Stock.
Le Neve Foster Prize	105	11	7	3½ per Cent. War Stock, chargeable with the Award of a Prize.
	40	0	0	4½ per Cent. War Stock.
Amount to cover accumulated Interest on Trust Funds	400	0	0	On deposit with Messrs. Coutts & Co.
	£16,170	6	10	

TOTAL OF INVESTMENTS, ETC. (FACE VALUE), STANDING IN THE NAME OF THE SOCIETY (INCLUDING SOCIETY'S ACCUMULATED FUNDS AND TRUSTS AS ABOVE).

Ground-rents (amount of cash invested)	£17,669	4	0
War Stock 4½ per Cent.	1,148	8	4
War Stock 3½ per Cent.	105	11	7
Metropolitan Railway 3½ per Cent. Preference Stock	571	0	0
Bombay and Baroda Railway Guaranteed 3 per Cent. Stock	648	19	7
India 3 per Cent. Stock	3,795	19	8
India 3½ per Cent. Stock	3,429	10	10
Canada 3½ per Cent. Stock	500	0	0
South Australia 4 per Cent. Stock	605	16	0
New South Wales 3½ per Cent. Stock	786	4	2
New South Wales 4 per Cent. Stock	500	0	0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cent. Stock	100	0	0
Natal 4 per Cent. Stock	500	0	0
Newcastle-on-Tyne 3½ per Cent. Stock	3,000	0	0
Metropolitan Water Board B. Stock	321	15	9
New River Company Shares	6	0	0
Cash on Deposit with Messrs. Coutts & Co.	400	0	0

Society's Accumulated Funds	20,080	3	1	£36,250 9 11
Trust Funds held by Society	16,170	6	10	

The Assets, represented by Stock at the Bank of England, and Securities, Cash on Deposit, and Cash balance in hands of Messrs. Coutts & Co., as above set forth, have been duly verified.

SANDERSON,
WILLIAM H. DAVISON, } *Treasurers.*

H. T. WOOD, *Secretary.*
KNOX, CROPPER & Co., *Auditors.*

Society's House, Adelphi, 21st June, 1916.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Sixty-second Annual General Meeting, for the purpose of receiving the Council's report and the Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new Fellows, will be held, in accordance with the By-Laws, on Wednesday, June 28th, at 4 p.m.

(By order of the Council),
HENRY TRUEMAN WOOD, *Secretary.*

INDIAN SECTION.

Thursday, June 29th, 4.30 p.m.; SIRDAR DALJIT SINGH, C.S.I., Member of the Council of the Secretary of State for India, "The Sikhs." THE RIGHT HON. AUSTEN CHAMBERLAIN, M.P., Secretary of State for India, will preside.

EXAMINATIONS.

The results of the Advanced (Stage III.) Examinations, held from April 10th–19th, were posted to the Centres concerned on the 21st inst. It is hoped to publish the results of the Intermediate Stage early next month, and of the Elementary Stage a few weeks later. The publication of the results is this year considerably delayed owing to the war, as not only is the Society's staff considerably depleted, but the Examiners have also lost the services of many assistants, who have joined H.M. Forces.

THE PLACE OF SCIENCE IN EDUCATION.

By DR. J. A. FLEMING, M.A., F.R.S.,
University Professor of Electrical Engineering in University College, London.

On all sides we see evidence of a widespread feeling that we shall not be able to secure our national position after the sacrifices of the war unless attention is at once given to the more systematic development and application of scientific knowledge, and a radical improvement effected in its position in our educational schemes.

This opinion is showing itself in the establishment of numerous Committees, Boards, and Conferences of various kinds. These discussions may be necessary to clear the ground and awaken interest, but they will be futile if they have no other result than mere assertions of national inefficiency or neglect.

The need of the moment is a careful and searching analysis of the causes of this failure

to cultivate sufficiently scientific knowledge, and of the small popular appreciation of it, and we shall then perhaps be able to agree on the practicable remedies. Above all, we must estimate and define its proper place and function in popular education, so that we may not err in undervaluing or in overstating its importance.

In the last half century there has been an enormous progress in our knowledge of the physical universe and in the degree to which we are able to control its inexhaustible energies, powers, and materials for human purposes. It has been found that this knowledge not only brings great benefits in its train, but also that it is unfortunately applicable also in the most effective service of the powers of evil.

Hence we are compelled to pursue it not only for its intrinsic advantages, but also that we may meet and control misapplications of this knowledge, and prevent ourselves from being brought into subjection to those whose ethical development has not kept pace with their progress in using scientific knowledge.

A careful study of the subject shows us also that a too exclusive attention to the material side of Nature, and to its purely physical phenomena, has its special dangers and disadvantages.

The important questions which therefore arise for consideration are the place and character of the instruction in science which should be given in primary and secondary education; in the next place, the mode and means by which an intelligent public interest in, and appreciation of, scientific knowledge may be stimulated; and, thirdly, the steps which should be taken to encourage and assist scientific investigation.

As regards elementary education, our first duty to the child is to teach him or her something of the laws and phenomena of the physical universe into which it has been born, something concerning its own bodily structure and powers, so that it may learn to live well and in right relations to its fellows, and also to other forms of life around it.

The young child is naturally vastly curious and interested in its new surroundings and asks to be instructed, but the majority of children are deliberately educated into stupidity by the greater stupidity of adults around them, who cannot answer the child's questions and will not take the trouble to learn how to do it.

The child is by nature a philosopher eager to know the reasons for things; an experimentalist ready for all risks; and an artist who lives in a world in which imagination clothes ugly facts in picturesque raiment.

Right methods of education take advantage of all this to enable the child to educate himself. The success of the Montessori system of training young children is based on the fact that the child is naturally an experimental philosopher. The instant and permanent triumph of the Baden Powell Boy Scout movement was due to the right utilisation of the boy's imagination and love of adventure. The cardinal and disastrous error made in elementary education, as administered by the State at present, is that it begins with language, words and books, instead of with things and natural phenomena. The first thing we do is to teach the child to read and "learn by heart." It learns to repeat strings of words, and at a later stage commits to memory an ill-assorted collection of information on grammar, history, geography and literature, all of which has small bearing at all on its immediate requirements. There is very little training of the hand and eye, and little or no pains taken to bring the town-born child in contact with Nature and Nature-study.

Meanwhile the picture palace has become the chief source of recreation to city-bred children, and its inanities, representations of disasters, to say nothing of the ineffable foolishnesses of much of its displays, have occupied the field to the great damage of the child's eyesight and the still greater damage to its mind.

Consider for one moment the great service the "moving picture" could render to education. It can in the first place represent to the eye moving animal life, the habits of animals and their ways of life. By taking photographs of growing plants at intervals of a few hours and then uniting them sequently on the film, it can represent the growth and development of a chestnut blossom or a blade of wheat in a few seconds, which in Nature takes days or months. It can thus bring to the eye the facts of botany and the perpetually repeated miracle of the spring or summer, and this appeal to the eye can be interspersed with short instructional remarks or explanations. It can give ocular demonstrations of facts in physics, mechanics or astronomy, which no stationary pictures can do. The progress of a solar eclipse, with all its impressive phenomena, can be shown to a class, and the action of a steam-hammer or petrol-engine explained in detail by motion pictures, which are under complete control. Instead of this we allow the whole of this

invaluable means of scientific education to be enlisted in the service of frivolity and the demoralisation of children by cheap exhibitions, which more than one police-court magistrate has described as an unmitigated evil.

If free access to these places is to be permitted to young children under fourteen years of age, the least that can be done is to establish a strict censorship over the character of the pictures shown, and to insist that a certain amount of educational work and Nature instruction shall be given by carefully selected films as well.

Then as regards school instruction in scientific knowledge, this should begin with elementary facts of astronomy and natural phenomena, such as the properties of air, water, and common substances, the effects of heat and cold, the simplest facts, light and sound, and the growth and structure of familiar plants and trees. All this should be taught by appeal to the eye and by motion pictures or models, the principal aim being to train the child's powers of observation, description and logical inference.

It will require a greater national expenditure than at present, but the nation has to learn the truth that there is no economy so false as economy in national primary education.

Coincidently with this Nature-study the child should be taught reading, writing, elementary arithmetic, and drawing; but beyond this the training of eye and hand, the practical arts of life, co-operative action in drill and dancing with the aid of music should take precedence of books and words.

The main thing is that the child shall be taught to *do* things, or effect practical achievements, and not simply to store memory with words, or the analysis of them. The right use of language, and its employment to describe experience, should be conveyed by example and imitation from the living teacher and not the dead book.

Turning then to a more advanced stage of education, we find at present a strong consensus of opinion that radical changes are necessary in the curricula of public schools. The large amount of time spent at present over the grammar and literature of Latin and Greek brings no return at all proportional to the effort and expense spent over it. The mental discipline can be obtained more usefully in other ways.

There are four great groups of educational subjects which should be put on an exactly equal footing, and claim each a quarter of the whole working time of the schoolboy. These are: (1) Language and literature, considered chiefly as a means of expressing thought and experience; (2) Science or a knowledge of the facts and laws of the physical universe; (3) Mathematics and graphics, or the study of number and form, including arithmetic, geometry and algebra, and drawing in various forms geometrical and freehand; (4) Civics, or the preparation for citizenship, which includes history, both of the world and of the native country, elementary political economy, religious or ethical instruction, elocution and military drill or exercises.

Assuming a total of working hours of about forty per week, this would give ten hours a week, or, say, 360 a year for the study of scientific subjects. In the next place we have to consider what these subjects should be. When science teaching was first introduced into schools, chemistry seems generally to have been selected, and under its schoolboy designation of "stinks" has been the principal subject always taught.

Chemistry is, however, by no means the best subject for initial instruction in science. It provides, of course, attractive experiments and requires no very expensive appliances, but it lends itself almost too readily as a subject for cram knowledge, whilst its necessary theoretical basis is difficult to expound. The chief object of school instruction in science should not be the mere acquirement of cut-and-dried information as to facts, but the cultivation of the student's powers of observation and experiment and drawing correct logical deductions therefrom. Hence it is far better to begin with mechanics, elementary physics and botany. A skilful teacher, provided with the proper apparatus such as that described in the late Sir Robert Ball's "Experimental Mechanics," can make mechanics an excellent introductory subject for school instruction. A properly equipped physical laboratory should form part of every school, and the work therein should consist in taking the boys, arranged in pairs or couples, through a carefully selected series of practical exercises in magnetism, heat, light, electricity and acoustics.

It is a great mistake to lecture too much to boys as if they were adults. This type of oral teaching is easy to give, but most ineffective in results. The students should perform the experiments and not the teacher, and the work should consist in making careful observations or measurements, which are then as carefully described by the boy in his own language in

writing. The proper description of experiments or observations in good, simple, lucid English should be strongly insisted upon, and marks given for this as well as for accuracy in results. The effort should be to make the boy rediscover for himself, under guidance, the elementary facts and laws of the subject under study.

It is advisable to postpone the study of chemistry until after the elementary physics and mechanics, and until a little training in experimental work has been acquired. In some schools a great show is made with carpenters' or engineering workshops. This impresses parents and attracts boys with a mechanical turn of mind. But there is little or no real scientific training in it. The making of a model steam-engine is an amusement for leisure hours or wet half-holidays, but is perfectly useless as a means of scientific education for boys. The school work should be confined to imparting a really practical and thorough knowledge of elementary principles of science. Of course, in all this the quality and kind of teaching given is the important factor. The mode in which a subject is taught is even of more importance than the subject itself. Chemistry can be so imperfectly taught as to be of little use as a mind-training. It is possible to give a very scientific lesson on a Greek verb, and also to give a lesson on an electrical machine which is not scientific teaching at all.

Hence here as elsewhere the man counts for more than the machine or apparatus. Nevertheless, the good teacher is wasted unless he has the necessary appliances. For this reason every public school should be adequately provided with museums containing geological, mineralogical, botanical and zoological specimens, and these should be continually increased and well arranged. The physical and chemical laboratory accommodation should be ample and well equipped. Every school should also have a small astronomical observatory with an equatorial telescope, clock, and transit instrument, and an outfit of surveying instruments, such as a theodolite, chain, level, and surveying staffs. Trigonometry as a mathematical subject should be taught in a practical manner by the aid of these last-named appliances, and not merely made to consist in the memorizing of formulæ.

Instruction in elementary astronomy, comprising a practical knowledge of the constellations and movements of the sun and moon, should form part of all school education. It is lamentable to notice how few adults even in the educated classes have the smallest knowledge of these things, or the faintest conception of the reasons for the tidal movements of the sea, the changes in the seasonal appearances of the starry heavens, the phases of the moon, or the phenomena of eclipses.

A classical scholar, on being told that on a certain night an eclipse of the moon would be visible, observed to the writer of this article that it was "fortunate" that the moon would be full on that night as the eclipse would be better seen. It is a most elementary fact of astronomy that it cannot occur at any other time except at full moon.

One of the essential things is to give proper dignity and importance to scientific knowledge and teaching. It has been far too long considered as the Cinderella of school subjects. The division of schools into classical and modern sides, accompanied as it has been by an air of unquestionable superiority on the part of the classical department, should cease.

One great reason, of course, has been the vastly greater inducements to classical studies by university scholarships and exhibitions, and the predominance awarded to them by the marks allotted in public and Civil Service examinations.

An influential meeting was, however, held lately, under the chairmanship of Lord Rayleigh, at which important resolutions were passed urging: (1) that the study of nature sciences should form an integral part of the educational course at all the great schools of the country and of the entrance examinations of the universities old and new; (2) that the Government should encourage this study by assigning capital importance to scientific knowledge in the competitive examinations for the Home and Indian Civil Service, and for admission to Sandhurst.

If these resolutions are acted upon by the authorities, pressure would at once be put upon the public schools to reform and augment their scientific teaching. We should not then in the future run the risk of our legislators in Parliament exhibiting, as they have done recently, the most astonishing ignorance of simple facts of chemistry.

Another and equally important reform would be the revision of the relative value of the scholarships and exhibitions offered at the universities for classical, mathematical, and scientific knowledge. At present there is evidence that the lion's share of these encourage-

ments falls to classics. Hence the public schools devote most attention to the subject which "pays" best. The right arrangement would be to put the subjects on an equal footing. If these recommendations were followed, the study of science would shortly cease to be regarded as of inferior importance, and would take its rightful and dignified position. It would no longer be regarded as a curious and unimportant hobby by those who know nothing about it, and an ignorance of the broad general facts of chemistry, physics, biology, or astronomy would be regarded as a mark of ill-education. What is required is, not merely to produce scientific specialists, but even more to create appreciation of, and sympathy with, scientific work and aims in the mind of the general public.

Assuming, however, that a reform in the public school methods will lay the foundations for this increased sympathy, it is then essential that scientific men should continually endeavour to place the results and methods of their work in such form as to encourage and justify public interest. The chief method by which this can be done is by public lecturing and also by written communications to the public press, chiefly the great daily newspapers and the more widely circulated general magazines. The public lecturing is by far the most important, because this can be illustrated by actual experiments, diagrams, lantern-slides, projections, or specimens.

The art of public lecturing does not, however, come by nature, and an intimate special knowledge of a subject may yet be coupled with a great inability to expound it so as to fasten and stimulate general attention. Some of the great scientific workers of the past age and also of the present have, however, made this art of public exposition of difficult scientific matters a great study. Faraday, Tyndall, and Huxley were past masters in it. It demands not only trained elocution, but the power of marshalling ideas and uttering them in apt and forceful phrases with attention to time limits and public capacity to assimilate new ideas. Lecture experiments and demonstration need also special abilities and ingenuity.

The Friday evening discourses at the Royal Institution, or the afternoon lectures in the same place, may be taken to represent generally the highest achievements in this form of public teaching, as also do the similar lectures at the Royal Society of Arts. Most large cities have institutions at which similar public scientific discourses are given at frequent intervals. The Gilchrist Educational Trust has also done a great and useful work in the last thirty years in enabling large popular audiences all over the country to receive such instruction in scientific matters from the most eminent exponents and lecturers. The discussions and popular lectures at the British Association meetings are also of service in the same sense. The work has of course been interrupted to a large extent by the war, but when peace returns it must be revivified and extended. This primary and popular scientific teaching is, however, merely a preparation of the ground for more serious work.

We reach the core of the matter when we come to consider the place of science in university and technical teaching. Here the principal object in view is not merely the dissemination of information, but the instruction and training of men who can create new knowledge. Of late years the ancient as well as the modern universities have added greatly to their equipment in laboratories and museums, with all the appliances of scientific study. Nevertheless, too much of it has been devoted to the purpose of making graduates rather than investigators.

The chief function of a university is to increase our knowledge, and not merely to put the hall-mark of a degree on young men who have acquired a certain store of learning concerning the achievements of others. The obsession of the written examination paper and degree still holds us in its grip. Whilst it is essential to insist on a certain breadth of acquaintance with known things to prevent the creation of narrow specialists, the university does not accomplish its final purpose if it fails to animate its students with an intense zeal and some ability to push forward the confines of knowledge. Hence the main duty of a university is research. The duty of advancing pure scientific research is the particular responsibility of the science teachers and advanced students and graduates in it. No one is fit to fill the post of a university teacher who is not actively engaged in research in his own special department of knowledge. His success ought largely to be gauged by the degree to which he gathers round him students who can take part in and assist in new investigations.

The value of this work has to be measured by its quality as well as its quantity. There is at the present time an enormous output of published researches, but a great deal of this is work which is concerned with minor questions, quantitative measurements, and with the gleaning

of corners of the scientific field. The really great investigations are those which open for the first time some novel and rich mine of scientific truth. Such, for instance, were the epoch-making investigations of Sir J. J. Thomson on masses smaller than atoms; those of Hertz on the creation of electromagnetic waves; of M. and Madame Curie and Sir E. Rutherford on radioactivity; of Sir William Huggins on stellar spectroscopy, and of Röntgen on the X-rays.

A most important matter is the consideration of the conditions under which this stimulative originality can be fostered and increased. One thing is certain, that too much devotion to the study of what others have done is apt to diminish original powers. The great inventors and discoverers instinctively turn to new fields of research. When a man has this notable originative power, everything should be done to facilitate his possession of every material means necessary. It is the most wanton waste of rare gifts if an experimental genius is allowed to spend much of his life in a heartbreaking struggle to acquire merely the implements of research. The British nation has yet to learn the immense resources which in Germany, and also in the United States, are being put at the disposal of those who have proved powers of scientific investigation.

The German Emperor founded and obtained large funds by subscription not many years since for a special institution called the Kaiser Wilhelm Institute, devoted entirely to the highest class of scientific research, which is quite apart from and independent of all university work or control, or even of the Reichsanstalt, which is the German equivalent of our National Physical Laboratory. In the United States there are large endowments available for similar work, and anything which we possess is small by comparison. The better equipment of all our university laboratories is therefore an urgent matter.

It is not a day too soon, therefore, that the Government has created a Committee of the Privy Council to deal with scientific and industrial research, and an Organizing Council to direct the disposal of the funds which will be administered.

There are indications that this will be done by grants to learned scientific societies for special researches, by grants to universities and colleges, and to individuals and committees for definite research work. By the assistance of research scholarships and fellowships it will be possible to give the necessary financial assistance to trained men who have exhibited the necessary qualities of mind. We have to search diligently for this capacity and cultivate it, not simply to wait for it to turn up, and we may then hope to increase greatly the systematic pursuit of advances in scientific knowledge.

The direction in which all the above effort must tend is, however, in the application of this knowledge in commerce and the arts. If we are not to suffer hopeless defeat in the coming commercial contest of brains we have continually to bring this scientific knowledge to bear upon all the problems of industry.

One great difficulty which presents itself is the small faith which so many British manufacturers have at present in the utility of scientific research. This shows itself in the unwillingness to make the necessary investment of money in it.

The technical problems are often insoluble unless very considerable expenditure is made on the preliminary research. To make a large effective improvement in a dynamo, an optical glass, or a dye, an expenditure of anything from £20,000 to £100,000 may be necessary. It is, therefore, necessary to have a strong confidence in the ability of research to justify the expenditure. This can only be attained if the manufacturer himself has had sufficient scientific training and education to know the history of industrial developments and of the achievements of research power in aiding them. It all, therefore, comes back to the question of education. Give your manufacturer sufficient knowledge of what science has done and you will induce in him a stronger faith in what it can still do.

Again, if our educational methods are directed sufficiently to the production of men who can do new things, and not merely know about old ones, we shall provide the manufacturer with the men who can give him the efficient assistance. We have, therefore, to make science an integral part of our national education. We have to create conviction in the public mind that only in this manner can we forge the weapon which shall give us the ability to retain our place as a world power. We have, therefore, to reconstruct the basis on which our educational systems rest and make a study of the laws, phenomena and processes of Nature of primary importance in them.

It has to be clearly realised that, great as are the victories of science in the past, there are revolutionising discoveries and inventions yet

to be made which will affect human life in every way. We cannot afford to be and remain content to have no part in them, but they will only come as the reward for strenuous labour on our part. We may not be able to effect all the reforms in education which are an essential precursor, but we can do something, and we can do it at once.

DECLINE OF PINE-APPLE INDUSTRY IN THE AZORES.

St. Michael pine-apples—the raising of which has for years been the principal industry of the Azores—promise to follow in the wake of the Azorean orange. The orange was destroyed by a parasite; the pine-apple industry promises to be destroyed by overproduction and the reduced purchasing capacity of Hamburg and London markets since the war. In fact, the war has forced ruinous prices upon the local growers, many of whom are turning to different lines—some to tomato cultivation and some to the orange—while others are emigrating to the United States. A once flourishing industry, yielding nearly £200,000 a year to the people of St. Michael, has thus come to a standstill. The 1913 exports were valued at £109,000, and in 1914 they had declined to £64,000.

According to a report by the United States Consul at St. Michael, the pine-apple industry of the Azores dates back to 1860, when it was discovered that the soil and climate of St. Michael lent themselves to the production of a superior fruit. Because of their size and luxuriant foliage St. Michael pine-apples sold as high as £1 each in the early days of the industry. Fortunes were made in a very few years. The expectation of fabulous returns prompted hundreds to plant the fruit. All became wealthy.

Now thousands are engaged in pine-apple culture. The result has been, as stated, overproduction. When the production reached 50,000 cases annually, or 600,000 pine-apples, fancy pine-apple stock still brought 6*s*. to 8*s*. each in the London market. To-day, when the production is more than 2,300,000, the producers are obtaining only 6*d*. to 1*s*. 9*d*. each for their fruit.

When the war destroyed the European market, the local growers endeavoured to dispose of their fruit in New York, Lisbon, and Gibraltar, but nowhere with marked success. The Azorean pine-apple being a high-priced fruit, it was soon discovered in New York that it could not compete with the cheaper Hawaiian product. At the time the report was written only Lisbon was buying in considerable quantities, and was proving to be an unprofitable market. Growers in St. Michael, it is said, were actually selling their crops at 25 to 50 per cent. below the cost of production.

In former years Hamburg took about 65 per cent. of the St. Michael pine-apple crop for distribution in Germany, Austria, and Russia; London took 20 per cent., mostly the finest fruit; and Italy and France took the remainder. The decline in the industry is well illustrated by the following figures of exports during the five years ending 1914:—

Year.	Cases.	Value.
1910	128,000	£140,400
1911	134,000	£116,600
1912	145,000	£104,400
1913	170,000	£108,800
1914	175,000	£64,400

EXPERIMENTS IN OPTICAL PYROMETRY.

In a recent publication of the United States Bureau of Standards, a new method for determining the "effective wave length" of the colour and absorption screens used in optical pyrometry is described as applied to several specific screens and glasses. The shift of effective wave length with change in temperature of the source, and the effect this shift may have upon the accuracy of temperature measurements, are discussed. It is shown, both theoretically and experimentally, that for precise work at high temperatures, with pyrometers using colour screens, a thorough knowledge of the change of the effective wave length with temperature is required.

This publication, Scientific Paper No. 260, "The Centre of Gravity and effective Wave Length of Transmission of Pyrometer Colour Screens, and the extrapolation of the high-temperature Scale," may be obtained by persons interested from the Bureau of Standards, Washington, D.C.

RE-DEVELOPMENT OF SERICULTURE IN SPAIN.

Sustained efforts by civic bodies and individuals in the Valencia district, aided by similar influences in other parts of Spain, to create an interest in and develop the long decadent silk industry, have at last produced definite results, the Spanish Government having drawn up and presented to the Cortes a bill with this object in view. The proposed legislation includes a grant of 840,000 pesetas (about £33,600) a year, 300,000 (£12,000) of which are for the support of experiment stations, 100,000 (£4,000) for free distribution of mulberry trees, 60,000 (£2,400) for free distribution of silk-worm seed, and the remainder for premiums to sericulturists and spinners of raw silk.

In reporting on this subject to his Government, the U.S. Consul at Valencia points out that the proposed law is of particular interest to that district, as sericulture is now and has always been chiefly centred in three of its provinces, viz., Murcia, Valencia and Alicante (in order of importance).

The preamble of the proposed law states that prior to the epidemic in 1848, when the decline began, the Spanish production of cocoons was 12,400,000 kilogrammes (kilogramme = 2·2 lb.),

valued at 70,000,000 pesetas (£2,800,000), whereas at the present time, after a partial revival, it is only 1,250,000 kilogrammes, valued at 4,500,000 pesetas (£180,000).

Corresponding to the preponderating interest of the Valencia district, the largest and best equipped silk experiment station in Spain is in Murcia Province. It was given an official status by Royal Order of May 3rd, 1892, having existed for some time previous through the initiative of public-spirited individuals. The activities of this station include the theoretical and practical encouragement of the silk industry in all its phases, with gratuitous distribution of young mulberry trees and silkworm seed, and advice for obtaining the best results. Government silk stations are also maintained, chiefly for the cultivation and distribution of mulberry trees, in Puerta de Santa Maria (Cadiz) and Aranjuez. Under the proposed law the activities of the stations will be broadened, but the Murcia station will still be the chief Government agency for the rehabilitation of sericulture in Spain.

ENGINEERING NOTES.

The Kiel Ship Canal.—Owing to the paramount interest of the political and commercial world in this undertaking, which shortens the route from London to Petrograd by 238 miles, and from Hamburg to Petrograd by 424 miles, it is not surprising that its engineering features are, to a great extent, lost sight of. During the war, however, German warships are alone admitted, and commerce derives no benefit from the world's greatest ship canal; for, with the sole exception of the Suez Canal, which is only greater as regards length, the Kaiser's canal is pre-eminent in dimensions. The Kiel waterway was opened in 1887, the cost being £8,000,000, but was enlarged in 1895 at an additional cost of about £4,000,000, to accommodate the super-Dreadnoughts which the warlike ideas of the Kaiser's advisers rendered necessary. Both ends of the canal are strongly fortified. As to dimensions, the following figures transferred approximately from the *London Magazine* will be clear in this respect. The canal is about 63 miles in length as against 41 miles, which is the length at Panama; the width at bottom is 144 ft., and at top 344 ft., affording passing places at moderate speed. The locks, two at each entrance, which may be pumped dry to serve as dry docks, are 1,150 ft. long, 147 ft. wide, and 46 ft. deep, comparing with, respectively, 1,000 ft., 110 ft., and 39 ft. at Panama. Special attention was paid to the curves, the water-levels at these places being considerably widened. Moreover, at suitable intervals new sidings were built, some of them stretching a distance of 4,000 ft. In these sidings alone, there being eleven all told, a fleet could lie at anchor without interfering with the passage of other vessels. The canal is crossed by two road bridges, five railway bridges, and sixteen wire-rope ferries. The railway bridges have each a clear elevation of 150 ft.

Tank Tests with Ship Models.—In a paper read by Mr. G. S. Baker, the Superintendent of the National Physical Laboratory Tank, at Teddington, Middlesex, before the Liverpool Engineering Society, he remarked that the cost of overcoming ship resistance forms one of the largest items on the balance-sheet of any vessel in the Mercantile Marine. In arriving at an estimate of the power that will be required, the designer makes use of existing data derived either from existing ships, or from model experiments, or, better still, from a combination of both. The data must be to hand in a standard tabular or diagrammatic form, and with their help it is often possible to make a reasonable estimate, sufficiently accurate for preliminary purposes, even for quite large departures in dimensions and type from any existing ship. An unnecessarily high estimate of power means an unnecessarily high outlay on the engines and their upkeep, and a reduced cargo capacity for the life of the vessel. The routine testing of models is a proper thing from the designer's point of view, as it prevents any error in shape and is an advantage to the owner, as he can rest assured that his coal bill will be a minimum if the ship is properly handled. From progressive trials, if they are carefully conducted and properly analysed, the efficiency of the ship and propeller can be approximately determined, but their complete analysis is impossible without tank experiments. The designing office may use a tank to its own advantage in many ways. For instance, a good collection of data from model screw experiments is now in existence, which can be used for rapidly determining the proportions of propellers for any vessel. A detailed description of the National Physical Laboratory was published in the *Journal* of the Royal Society of Arts on December 26th, 1913.

Electrical Power in Ontario. — The Canadian correspondent to the *Electrical Review* writes: One of the most important occurrences in the electrical supply situation in the Province of Ontario is the recent arrangement made by the Provincial Government to purchase, at a cost of over £1,600,000, all the interest of the Trent Valley power companies whose operations cover the territory lying east of Toronto, along the shore of Lake Ontario. This means that the water rights and properties of these companies are purchased for the people, and that they will be put directly under the administration of the Hydro-Electrical Power Commission of Ontario, and it also means that with the exception of the large companies on the Canadian side, at Niagara Falls, practically all the large power sites and projects are now held by the people and controlled by the Commission. As was recently pointed out in these notes, the territory at the present served by this Commission

is almost as large as England, while its powers, extending over the whole province as they do, cover an area three and half times as large as the British Isles. The Provincial Government has decided to approve of the power development scheme proposed by the Commission for the Niagara River, whereby an ultimate capacity of 600,000 h.p. will be made available. For this scheme turbine and generators in units of 50,000 kws. capacity are being considered.

The Conversion to Electricity of a Swiss Railway: Direct Current, Three Phase or Single Phase.—The General Management and the Standing Committee of the Swiss Federal Railways have just submitted a report to the Council of Administration in regard to the projected conversion of the Erstfeld Bellinzona section of the St. Gothard Railway. It is first pointed out that the three-phase system would be unsuitable for the purpose in view, whilst the advocates of the direct current method base their contentions on experience with lighter trains, and pressures far below 3,000 volts. The single-phase system, which is already employed on the Lotschberg Railway, can now be recommended for adoption without reserve. No other electric railway exists which can be placed on an equality in regard to the varied nature of service, the number of locomotives, length of the track, and extent of services rendered, with that of the New York, New Haven, and Hartford Railway. At the same time this railway is the first which, owing to the system used, has proved itself to be extensible at will, and capable of being accommodated to all kinds of services. In the case of the Lotschberg Railway, the interruptions in working were attributed chiefly to the difficult circumstances under which the electrical equipment had to be provided. The report also discusses the problem of uniformity in the form of current and periodicity, which it is sought to attain in the distribution of energy throughout Switzerland. The Amsteg and Ritom power-stations, which are proposed for the working of the Erstfeld Bellinzona section, will be able to furnish energy not only for this section, but also for the whole line from Lucerne to Chiazzo, the conversion of which will not be long deferred.

ARTS AND CRAFTS.

Home Arts and Industries.—The annual exhibition of the Home Arts and Industries Association has been held for so many years at the Albert Hall that it seemed strange last month to find it confined within the comparatively narrow limits of a private house. The society is one which has for so long quietly, persistently, and unostentatiously urged the claims of craftwork and craftworkers, and which has had so large a share in the revival of home arts and of peasant industries, that it would have been a real calamity had the war seriously interfered with its activities. Apparently the reduced size of this year's show is due not so much to classes having stopped, as to some inevitable falling-off in numbers, and still more to the various difficulties in the way of holding a large exhibition of this type in war time. As was only natural under the changed circumstances, the great majority of the exhibits consisted of needlework, lace and textiles of various kinds; but some toys were shown and a fair amount of leatherwork, the best of which came from Leighton Buzzard and was largely the work of cripples. There is not, of course, a very great demand for expensive leatherwork, and the doing of it takes some skill; still the work is not heavy and, with the exception of bookbinders' tooling, does not involve a great outlay in tools, so that it really seems as though this were one of the crafts which disabled soldiers and sailors could take up, if not exactly as a means of livelihood, at least as something more than a pastime. In some of the London shops at the present time there is a good deal of handmade leatherwork on sale which seems to be finding a market. Be that as it may, Lady Egerton claimed that her exhibit of what, for want of a better name, may be called Greek embroideries, illustrated a type of work which could be readily learnt and successfully carried out by crippled or disabled men. They would want capable direction no doubt to begin with, but that they might eventually make good needlemen there is no reason to doubt. The great bulk of the best embroidery, not only in the Far East, but so near home as Brittany, is done by men, and those who have first-hand acquaintance with the working of the Brabazon scheme generally find that in workhouses at least the best work of this kind is done not as they would have expected by the women, but by the men. Amongst the needlework at the Home Arts, the embroidery on linen from Fisherton-de-la-Mere stood out as showing distinction in workmanship and conception, and the Celtic designs of the Dun Emer Guild carried out in linen thread coloured by vegetable dyes had an interest all their own, and added considerably to the attractiveness of munition workers' overalls and suchlike practical garments without making them look in the least unfit for their purpose. The gold and silver lace from Kingston Bagpuize was good, and it was satisfactory to note that the workers are now making shaped collars as well as straight lace by the yard. Some fine examples of Buckingham and other lace were shown, and weaving was represented by the work from the Barclay Workshops for the Blind and the London School of Weaving. Altogether the exhibition, small as it was, proved the vitality of the movement which it represented.

Hangings, Covers, and Wall Decoration.—Decoration on a large scale, except in a few exceptional cases, is practically at a standstill; but there is a fair amount of less important work which has to be done, and for which the shops are catering. Many

people, for instance, must have new curtains and covers, or find a room or two badly in need of repapering, and the wise householder naturally will not allow his places to fall into disrepair unnecessarily. What strikes one most is the prevalence of cotton furnishing fabrics. A few handsome silks are to be seen, and there is some tapestry about, but the textiles shown in the shops at present are in the main cotton. That is by no means equivalent to saying that they are cheap. It appears, indeed, as though there is a very large demand for expensive cotton fabrics, which is perhaps accounted for by the fact that people who normally would buy silk are content with cotton, but want something distinguished. Amongst these cotton goods, the desire to give the effect of some texture other than their own is almost as apparent as in wallpapers. By various means it is sought to make the ground, or sometimes the whole pattern, suggest a richer material than mere cotton. Shadow fabrics, again, are common. With regard to design, there is very little that is fresh, and Victorian and "Early English" patterns are very much in evidence, though there seems to be some return to all-over patterns of a more formal type. Indeed, the one thing needful at the moment seems to be for patterns to be full, and to cover as large a proportion of the ground as possible. Spots, sprigs, and very open scroll patterns and lattices appear to be quite things of the past. The tone is, on the whole, rather drab and sombre, although many of the designs are printed in a remarkable number of hues. This may be due to the difficulty of obtaining colours and a desire to make up for the poorness of the individual tints by introducing as many as possible and so confusing the eye. Certainly the colour of plain stuffs is not now as a rule satisfactory. On the other hand, there are a few examples of very bright, not to say staring colour, but they occur mainly in the case of fabrics in which the drawing and design is rather uncouth and the printing not very refined. Many of the more expensive wallpapers, especially those of a more or less Chinese character, are still being produced on black grounds, and one London firm is showing hangings, etc., of black satin, ornamented with bright pink roses in high relief made of the same material; but ordinary taste is demanding something at once lighter and more simple. Some of the wallpapers now to be seen come from America. This is to be regretted from two points of view. There was a time when paperstainers reckoned to export to the States, not to have Americans sending their goods over here, and business at present is not easy for British firms; further, it seems futile to be obtaining from the other side of the Atlantic just now commodities which we can produce as well, if not better, at home, while there is so much which has to be imported which is of primary importance, and which for the moment we cannot make ourselves.

CORRESPONDENCE.

EARLY CHINESE ZINC.

From 1893 to 1900 specimens of Chinese zinc were examined and found to be of very uniform appearance and quality. From inquiry the samples were said to have been taken from slabs, sometimes spoken of as "Ming" zinc. One such slab submitted to me weighed one picul (133⅓ lb.), and bore a date in deep well-moulded Chinese characters corresponding to 1585 A.D. The Ming Dynasty extended from 1368 to 1644 A.D. It was stated that although they were found to contain no silver the slabs had at one time been used as coins. There was much rumour as to the place of storage of these ingots. It was gathered that a large number were hidden in a hill near Lien Chow in the northern part of the Kwantung province. Also that the natives in the vicinity were much opposed to any sale or removal, on account of *Fung Shui*—the superstition which regards with extreme disfavour any interference with the soil. However, it is probable that difficulties were overcome, as after about 1900 no more was heard of this particular brand of Chinese zinc. All samples contained over 98 per cent. of metal, with very small quantities of iron and lead. Modern Chinese zinc is of about the same standard of purity.

The ore is said to be abundant in Hunan, Hupeh, Kweichow, and Yunnan, and in this last district to be extensively smelted.

FRANK BROWNE, F.I.C.,
Formerly Government Analyst, Hong-Kong.

MANUFACTURE OF RADIUM IN THE UNITED STATES.

I see in the *Journal* of March 24th a reference to the work of the Bureau of Mines in recovering radium from carnotite.

Dr. Kelly, of John Hopkins University, and I have provided the money for this small factory and for the cost of extraction, exclusive of the pay of the Government officials in the laboratory. Dr. Moore, who has charge of the laboratory, has quite fulfilled all his anticipations, both as to the cost of the radium and the quantity recovered.

The contract with the Government will expire on the first of next January, and not until after that date can the actual commercial cost of the radium be determined. Nevertheless, the cost is going to be considerably less than the market prices charged for radium.

Four grams of radium element have already been delivered to Dr. Kelly and myself—two grams to each of us—and I have very little doubt that as much more, if not three grams more to each, will be forthcoming.

My radium is now being used most effectually in the General Memorial Hospital here in New York. The hospital staff is satisfied that the full therapeutic effects of radium can only be obtained by using large quantities.

There will be no secrecy as to the chemical and

mechanical methods pursued at our Denver works, and therefore, when the experiments are closed, I will be very glad to give you complete detailed information. JAMES DOUGLAS.

NOTES ON BOOKS.

ON THE RELATION OF IMPORTS TO EXPORTS. Second Edition (enlarged). By J. Taylor Peddie. London: Longmans, Green & Co. 5s. net.

The appearance of a second edition of Mr. Peddie's volume so soon after the publication of the first, is only one among many signs that the question of our national economic system is at last beginning to receive the attention that its importance deserves. German methods of warfare have thrown fresh and lurid light on German methods of trade, and driven many former champions of Free Trade to the conclusion that their ancient faith must be modified when we come once more to meet the enemy on the fierce battlefields of peace. It is obvious that the more the whole question is discussed at present the better for the prospects of our future success, and Mr. Peddie's work, which is written in a reasonable and non-party spirit, must be welcomed as a sensible contribution to the subject, though we venture to think it might have been still more effective if he had taken greater pains with the manner of presenting his thesis.

In the principal addition which he has made to the second issue, the author sets himself to show that Adam Smith was not an advocate of Free Trade as it has come to be understood at present, but rather, as he puts it, of freedom of trade. It is a little surprising to find a question so academic being discussed by one who prides himself on being, above all things, a practical economist, and who has before this set himself to "ginger" up the old universities in the hope that they might be induced to make themselves and their teaching less remote from the realities of modern life; but although Mr. Peddie is apt to dispose of those economists who differ from him as mere theorists and scholars, he is not above a desire to secure for his own views the authority of "The Wealth of Nations":

"It is quite true to say that he [Adam Smith] sowed the seed of the present system, but it has been used and perverted by subsequent theorists in the development of their own vicious schemes, and who have manifestly misunderstood the intentions Smith had in view."

This sentence indicates the gist of Mr. Peddie's views on Adam Smith's economic followers, and incidentally illustrates the peculiarity of his literary style, to which attention has already been directed.

ENGLISH MURAL MONUMENTS AND TOMBSTONES. By Herbert Batsford and W. H. Godfrey, F.S.A. London: B. T. Batsford. 12s. 6d. net.

In this volume we are presented with a collection of eighty-four photographs of wall tablets, table tombs, and headstones of the seventeenth and eighteenth centuries, which have been selected by Mr. Herbert Batsford, "as representative examples of the beautiful and traditional types in the English parish church and churchyard, for the use of craftsmen and as a guide in the present revival of public taste." A brief introduction is contributed by Mr. W. H. Godfrey, and there is a short account of English mural monuments and tombstones, but the illustrations are the most important part of the work. The subjects have been chosen with great care and taste; among them are some very well-known specimens, such as the monument to John Stow in the church of St. Andrew Undershaft; but the reader will also find a great many examples—some of them very interesting and artistic—from remote corners of the country with which he is probably not familiar.

The book has been compiled with a very definite object, and it is to be hoped that it will be studied by designers of mural tablets and tombstones, for they will find in it much to stimulate their interest and guide their taste. A careful consideration of the photographs confirms one in one's predilection for severe simplicity and heraldic, or at all events conventional, ornament. Figures, unless they are carved by first-class sculptors, can hardly ever be satisfactory. Even in the monument erected by Sir Christopher Wren to his wife in the crypt of St. Paul's, the cherub who is wiping his eye with his finger is rather comical; and one knows what a dreadful thing an angel may become in the hands of the Kensal Green monumental mason.

We have before this had occasion in these columns to compliment Messrs. Batsford on the manner in which they turn out their books, and it seems hardly necessary to mention that in the case of a volume for which Mr. Herbert Batsford is himself almost entirely responsible, none of their usual care has been spared by the publishers.

GENERAL NOTES.

BACTERIOLOGY IN QUEENSLAND.—Special efforts have of late years been made in Queensland for the application to practical purposes of bacteriological research. A well-equipped experimental station has been established near Brisbane, with the special object of carrying out tests and inquiries on the application of bacteriology to purposes connected with Queensland industries. Chief amongst these is the prevention of disease in sheep and cattle, they also include the improvement of methods of meat-canning, and the development of cheese manufacture. In these and other branches of industry important results have already been obtained by the special researches of the Queensland bacteriologists.

EXPORT OF GRAPES FROM ALMERIA IN 1915.—The export of grapes from Almeria, which forms one of the principal resources of that province, shows a falling-off of 466,323 barrels, or 26·11 per cent., last year, as compared with that of the

previous one, which was considerably less than that of 1913. The total quantity of grapes shipped from the port of Almeria during the last three years was:—

	Barrels.
1913	2,049,320
1914	1,785,320
1915	1,318,997

On the other hand, the quality of the fruit was superior, and obtained higher rates on the English and American markets, where the prices ranged from 8s. to 18s., and from $4 to $6 per barrel respectively.

MEETING OF THE SOCIETY.

INDIAN SECTION.

JUNE 29, 4.30 p.m.—SIRDAR DALJIT SINGH, C.S.I., Member of the Council of the Secretary of State for India, "The Sikhs." The RIGHT HON. AUSTEN CHAMBERLAIN, M.P., Secretary of State for India, will preside.

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, JUNE 27...Colonial Institute, Northumberland-avenue, W.C., 5.15 p.m. Mr. T. B. Browning, "Indian Title in Canada."

WEDNESDAY, JUNE 28...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting.

Geological Society, Burlington House, W., 5.30 p.m. 1. Dr. A. S. Woodward, "On a New Species of *Edestus* from the Lower Carboniferous of Yorkshire." 2. Mr. A. Holmes, "The Tertiary Volcanic Rocks of Mozambique."

THURSDAY, JUNE 29...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Sirdar Daljit Singh, "The Sikhs."

Institution of Municipal and County Engineers, Blackpool, 11 a.m. (Annual General Meeting and Conference.) 1. Presidential Address. Selections from following papers:—2. Mr. J. W. Hipwood, "Some Experiences of a Municipal Engineer on Active War Service." 3. Mr. C. J. Jenkin, "A Municipal Engineer in Serbia." 4. Mr. J. S. Sawdon, "Municipal Work at St. Anne's-on-the-Sea," with special reference to the Ashton Gardens, and Open Air Swimming Baths. 5. Mr. T. Arnall, "The Destruction of Roads." 6. Mr. W. H. Scholfield, "Improvement of Highways to meet Modern Conditions of Traffic." 7. Mr. C. H. Cooper, "Road Signs." 8. Mr. A. E. Gattie, "Transport Reform." 9. Mr. H. A. Brown, "Public Abattoirs." 10. Mr. F. R. Phipps, "The Diesel Engine in Municipal Work." 11. Professor Abercrombie, "Civic Design." 12. Mr. J. H. Drew, "Surveyors: their Tenure of Office and Defence." 13. Mr. R. Brown, "Diagrammatic Statistics for Municipal Engineers."

FRIDAY, JUNE 30...Institution of Municipal and County Engineers, Blackpool, 11 a.m. Conference continued.

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

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FRIDAY, JUNE 30, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

ANNUAL GENERAL MEETING.

The one-hundred-and-sixty-second Annual General Meeting for receiving the Report of the Council, and the Treasurers' Statement of Receipts and Payments during the past year, and also for the Election of Officers and New Fellows, was held in accordance with the By-laws on Wednesday last, June 28th, at 4 p.m., DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, in the chair.

The SECRETARY read the notice convening the meeting, and the Minutes of the last Annual Meeting.

The following candidates were proposed, balloted for, and duly elected Fellows of the Society:—

Bandaranaike, Sir Solomon Dias, C.M.G., A.D.C., Horagolla, Veyangoda, Ceylon.

Bates, Mrs. Adah Lilian, 16, Summerland Mansions, Muswell-hill, N.

Bates, Thomas Bradford, 16, Summerland Mansions, Muswell-hill, N.

Bates, Thomas House, 21, Summerland Mansions, Muswell-hill, N.

Bilimoria, A. J., Navsari Buildings, Fort, Bombay, India.

Cropper, L. Cuthbert, F.C.A., Spencer House, South Place, E.C.

Davies, Henry James, Wingfield-park, Lucknow, United Provinces, India.

Gaby, Frederick Arthur, Hydro-Electric Power Commission of Ontario, Toronto, Canada.

Ghose, S. C., 221, Lower Circular-road, Calcutta, India.

Gordon, William John, 83, Thurleigh-road, Balham, S.W.

Hendley, Colonel Thomas Holbein, C.I.E., L.R.C.P., M.R.C.S., 4, Loudoun-road, St. John's Wood, N.W.

Kaul, Indra Krishna, B.Eng., Assoc.M.Inst.C.E., A.M.I.E.E., State Electrical and Waterworks Engineer, Bahawalpur, Punjab, India.

MacFarlane, George Edward, F.I.A.A., A.C.I.S., 121, New Chester-road, New Ferry, Cheshire.

Mirams, Arthur Edward, F.S.I., M.R.San.I., Consulting Surveyor to Government of Bombay, Poona, India.

Moro, Arthur Reginald, 87, Gloucester-terrace, Hyde-park, W.

Phillips, Gwilym, 22, Leslie-terrace, Porth, South Wales.

Piggott, Sir Francis Taylor, M.A., LL.M., Little Woolpits, Ewhurst, Guildford, Surrey.

Richards, James Garfield, Sydney-on-Vaal, District-Barkly West, South Africa.

Tyrie, Colonel David A., V.D., A.D.C., 21, Strand-road, Calcutta, India.

Vail, Theodore N., LL.D., 26, Cortlandt-street, New York City, U.S.A.

Venables, William Henry, 129, Fordwych-road, Cricklewood, N.W.

Waterbury, John I., 14, Wall-street, New York City, U.S.A.

White, Kenneth M., Minas Schwager, Coronel, Chile.

The Chairman appointed Mr. Byron Brenan, C.M.G., and Mr. Ernest Alexander West scrutineers, and declared the ballot open.

The SECRETARY then read the following—

REPORT OF COUNCIL.

I.—ORDINARY MEETINGS.

Of the twenty papers which were read before the Society during the past session, fifteen were more or less directly connected with the war, while five dealt with other subjects. It may also be added that the opening address, which Dr. Dugald Clerk delivered as Chairman of the Council on November 17th, may be included in the former category, since he chose for his subject "English and German Methods Contrasted." The address was an able defence of English methods as compared with the much-vaunted system of Germany. As Dr. Clerk said, German methods have for long been extolled as scientific, accurate, and far-sighted, while

those of benighted England were set down as amateurish, inaccurate, and short-sighted. This view has been taken by men representing various branches of science, literary men, politicians, and even sailors and soldiers. Its falsity was vigorously demonstrated by the Chairman, who, after first appealing to statistics, went on to prove that alike in most branches of natural knowledge, and in their application to practical purposes, Englishmen had not only been pre-eminent in original discovery, but also in the development of industry and science. The arguments employed need not here be repeated, but the last words of the address may well be quoted: "All the appearance called unpractical, illogical, or muddling through, is but appearance. England is not unpractical. She is the most practical nation in the world. She is not formally logical, but she is idealistic, her ideal being that of freedom for her sons and for the whole world of nations, small and large alike."

The demand for copies of the address proved to be so large that it had to be reprinted, and after its publication in the *Journal* a separate edition of 2,000 copies in pamphlet form was issued and distributed.

All three of the papers which occupied the attention of the Society at the meetings before Christmas dealt with matters connected with the war. On November 24th Sir Edwin Pears utilised his long experience of Turkey and the Turks in an admirable account of "Constantinople, Ancient and Modern," in which he summarised the history of that marvellous city, and from it deduced its probable future. The conclusion he eventually drew is that anybody who thinks that the great bulk of the Eastern trade will be attracted through Mesopotamia and Turkey is "a dreamer who ignores facts."

At the following meeting Dr. Arthur Shipley, the Master of Christ's College, Cambridge, dealt with the curious but unpleasant subject of "Insects and War." It is certain that before the outbreak of this war few of us generally realised the special part played by insects as carriers of disease and pestilence in war. Recent investigations have, of course, made us familiar with the action of insects in the carriage of malaria, and in the distribution of various filth diseases; but probably few, if any, had realised the noxious effect of these loathsome little pests.

At the second meeting in December, Colonel W. A. Tilney impressed upon his hearers the importance, from a military point of view, of an elementary knowledge of astronomy, and described the simple system which he has devised for rendering soldiers so far familiar with the principal stars as to enable them to find their way about at night-time.

Of the papers read at the meetings after Christmas four treated the effects of the war upon commercial supplies. The first of these, by Mr. J. Arthur Hutton, Chairman of the British Cotton Growing Association, dealt with the Effects of the War on Cotton Growing in the Empire and its prospects in the future. The paper was in effect a summary of the work of the British Cotton Growing Association, and showed how much had been done by it in encouraging the growth of cotton within the Empire. The value of this work may be appreciated from Mr. Hutton's statement that the Colonial revenues are now benefiting to the extent of something like £150,000 a year in direct consequence of the cultivation of cotton, while the cotton and seed produced under the auspices of the Association now amount in value to over £1,000,000 per annum, and the demand for British manufacturers has been increased to the extent of at least £500,000 a year.

Mr. Charles Phillips' paper on "Paper Supplies as affected by the War" came at a singularly appropriate time, because it practically synchronised with the Proclamation restricting the imports of paper materials; in fact, Mr. Phillips was able to announce unofficially that the Commission had decided on a restriction of 33⅓ per cent., an announcement which was immediately confirmed by the formal Proclamation.

The third paper coming within the same class was the one by Mr. Edward P. Stebbing, Head of the Department of Forestry at the University of Edinburgh, on "Forestry and the War." The main point of Mr. Stebbing's paper was his insistence on the immediate need for the development of forestry and the increase of the area devoted to the raising of timber. There can be no doubt that the depletion of our home woods and forests, caused by the need of replacing supplies previously provided from external sources, gravely emphasises the special need for re-afforestation after the war.

Sir Henry Cunynghame, in his paper on the "Supply of Food in Time of War," which was read at the first meeting after Easter, laid stress on the diminution of our wheat supplies which regularly takes place in the summer, the store

of wheat in this country falling from seventeen weeks' consumption in November down to about five in August. With a view of remedying this condition of affairs, Sir Henry Cunynghame drew attention to the scheme he had submitted to the Royal Commission on Food Supplies in 1903, under which importers would be encouraged to store their wheat by the imposition of a duty on all imported wheat which was not stored for a certain period. Under this arrangement it was proposed that the tax might be, say, 4*s.* a quarter, that the importer should bond his corn, and that the duty should be reduced a shilling for each month during which the corn was stored; so that if he kept it for four months he would pay no tax at all. The proposal, though received with appreciation, was not entirely approved by those who took part in the discussion, special importance being attached by the Chairman (Captain Charles Bathurst, M.P.) to the greater need of supplementing our imported supplies by home-grown corn.

A considerable variety of topics was discussed in the papers yet to be mentioned as included in the class of war papers, and to these reference may now be made.

The Hon. Lady Parsons, in her paper on "Women's Work during and after the War," gave a careful summary of the more important occupations into which women have been attracted since the war began, and indicated the lines on which she hoped that the employment of women in professional and intelligent work would be developed as a result of the special conditions now existing.

Mr. Charles Darling, whose lecture on Field Telephones in July last is mentioned in another part of this Report, gave a clear and interesting account of the Optical Appliances specially used in Warfare. The account was as complete as it could be made, having regard to the restrictions on the publication of any of the most recent developments of such apparatus as range-finders, periscopes, searchlights, and the like.

In her paper on "Serbia as seen by a Red Cross Worker," Miss H. B. Hanson, M.D., gave an interesting account of the escape from Serbia of the hospital staff employed in that unhappy country when it was overwhelmed by the Teutonic invasion.

Dr. R. W. Seton-Watson's paper on "Pan-German Aspirations in the Near East," was a brilliant account, by one possessing a minute knowledge of the country, of what he believed to be the real German aims and objects in the Balkans and beyond.

In his paper on "Neutral Merchants and the Rights of War," Sir Francis Piggott gave a lucid exposition of the present law of blockade, and urged the necessity, while he pointed out the justice, of the system now adopted by Great Britain to prevent supplies reaching the enemy by the aid of neutral nations.

Although Professor J. A. Fleming's paper on "The Organisation of Scientific Research" did not ostensibly deal with the conduct of the war, or with conditions brought about by it, it must yet be considered as connected with the results of the war, because the question has really been brought to the front by a realisation of the necessity for our organising all our resources, alike scientific and industrial. Professor Fleming was urgent on the need for some more definite organisation for the carrying out of experimental research and invention, and sketched out a scheme by which he thought this might be effected, and by which employers of labour might be encouraged to make greater use of scientific expert advice than they have hitherto done. The paper produced an excellent discussion, in which opinions, both for and against the proposals of Professor Fleming, were brought forward, and it was a valuable contribution to the settlement of a question which is now occupying much public attention.

Two papers yet remain to be mentioned whose sole connection with the war is the sad one that they deal with the country which has undeservedly suffered most from it—Belgium.

The first of these was the joint paper, on December 15th, by M. Josef Denyn, the well-known Carillonneur of Malines, and Mr. William Starmer, who is the best-known English authority on the same subject. These gentlemen gave a most interesting account of the mechanism and methods involved in the campanological art of which the former is so eminent a practitioner. The second was a delightful essay on modern Belgian literature, read in French, by M. Charles Delchevalerie, who took for his actual subject, "Maeterlinck, Verhaeren et les Lettres belges."

Of the five papers which had no bearing on the war, the first was the one read on January 19th by Mr. Lawrence Chubb, the Secretary of the Commons and Footpaths Preservation Society, on the history of the Preservation of the Common Lands of London. The Society of which Mr. Chubb is secretary had intended to celebrate their Jubilee (the

meeting at which they were founded was held at the Mansion House on January 24th, 1866) by a suitable public meeting. This proposal was abandoned in consequence of the war, and the occasion was commemorated by the reading of Mr. Chubb's paper, the date being purposely arranged as near as might be to the fiftieth anniversary of the Society's inauguration. The paper, therefore, was practically a brief history of the work of the Commons Preservation Society, and a most interesting record of valuable public service it proved to be. Lord Eversley, the founder of the Society, excused himself on the ground of his age from taking the chair, which was filled by Lord Farrer, who has for many years taken an active part in the Society's work.

The next paper belonging to the same category, that by the Rev. P. H. Ditchfield on the "England of Shakespeare," was also associated with a commemoration as it was in the nature of a contribution on the part of the Society to the celebration of Shakespeare's Tercentenary. This had been looked forward to for several years, and had we been at peace would certainly have been a national ceremony of the greatest interest and importance. Mr. Ditchfield illustrated his description of Shakespeare's environment by a number of interesting photographs of churches, houses, and other buildings contemporary with Shakespeare and still existing in more or less complete preservation.

The three remaining papers to be dealt with were read in April and May. Mr. A. S. Jennings gave a very full account of the various ways by which mechanical methods have been made to replace the old system of applying paint and varnish to buildings and implements by means of a brush. To a large extent these methods were a development of the device for spraying colour on surfaces invented by Mr. C. L. Burdick, and described by him in the paper on "The Fountain Air Brush," which he read here in March, 1894. Besides this, the system of dipping, even for articles of very considerable size, has been greatly elaborated, and mechanical methods for effecting this were also described by Mr. Jennings. The whole paper, though it dealt with purely technical processes having a certain limitation in their application, was an interesting example of the manner in which in one industry after another—often in a very unexpected fashion—mechanical appliances are coming to take the place of the work of the human hand.

Students of textile history are well aware of the extent to which Europe in the eighteenth and the previous century was dependent upon the East for its supply of calico, either plain or printed; but probably very few, even of those who have paid a good deal of attention to the subject, knew what a large amount of handwork was employed in India for the production of coloured cotton fabrics. While it was known that very considerable quantities of block-printed calicoes had been imported into England, it certainly was not generally realised that a goodly proportion of these decorative fabrics was produced by hand. Mr. George P. Baker, in his description of the "East Indian Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries," and even more by the very remarkable collection of such fabrics with which he illustrated his paper, threw a flood of light upon a subject to which really very little attention has previously been directed.

The work of the session was concluded by the reading in abstract by Mr. John C. Moulden of the Essay on Zinc for which he was awarded the Peter Le Neve Foster Prize. Reference to the foundation of the prize will be found in another portion of this Report. It may be sufficient to say here that the essay by which the prize was gained was a very full and extremely valuable monograph on the whole subject brought down to the present date. The importance of the information conveyed was very greatly enhanced by the fact that there is at the present time an enormous demand for zinc for war munitions, and a very great deficiency in the supply. Some of the principal sources from which the metal is derived were at once cut off at the outbreak of war. But other sources have been, and are now being, rapidly developed, and in the future it may confidently be hoped that one result of the war will be a very great enlargement of the supplies of this valuable metal to be derived from places within the limits of the Empire.

II.—Indian Section.

At the opening meeting Mr. C. C. McLeod dealt with the flourishing Indian jute industry, an industry which, as was pointed out, has been built up solely by British capital and British energy. In 1829 only twenty tons of the raw product, a monopoly of Bengal, were exported, and until 1855 Calcutta did not possess a single jute-mill. In 1913 the exports of the raw material amounted to 80,000 tons and the number of mills on the banks of the Hooghly

was about fifty, providing employment for a quarter of a million native operatives. The total value of the exports, manufactured and unmanufactured, is now £40,000,000. Mr. McLeod earnestly maintained that Germany should be prevented from accomplishing after the war certain designs she is believed to have harboured before the war, or from continuing to enjoy the privilege of competing on equal terms with those who have made the trade what it is.

Two hundred millions of our Indian fellow-subjects are dependent upon agriculture or subsidiary industries. What is now being done to solve an immense problem was explained by Mr. James MacKenna, the Agricultural Adviser to the Government of India and Director of the Agricultural Research Institute, Pusa, in an able paper on "Scientific Agriculture in India." The Indian Budget of 1905-6 made provision for the creation of a much-needed Central Imperial Staff with an adequate supply of scientific investigators and experimental farms in each of the provinces. Results of far-reaching consequence have been already obtained, especially in the production at Pusa, by cross-breeding, of new varieties of wheat. It is, Mr. MacKenna says, a modest estimate to assume that in the course of a very few years the area under these wheats will reach at least 5,000,000 acres.

Another paper bearing on the economic resources of our Eastern Empire was that read by Professor Wyndham R. Dunstan, on "The Work of the Imperial Institute for India." Besides surveying past achievements, especially since the Institute became a Government institution thirteen years ago, he discussed the lines on which further progress can be made, not only in the extended utilisation of Indian products in British industries, but also by the promotion of industrial enterprise in India itself.

The official records of the great triangulation of India are contained in many voluminous Government reports. The interesting paper read by Sir Thomas H. Holdich had to do with the "romance" of Indian surveys, including the "tide of adventure" which, while the mapping of India itself was in progress, flowed into regions beyond our border and led to the accumulation of stores of geographical information. Trans-frontier explorations have been discouraged for many years in order to avoid "complications." In consequence of the adoption of this policy of excessive caution, as some consider it, a good deal of the romance which often clings to individual initiative and effort has for the present disappeared.

In a scholarly paper on the early dawn of the Maratha power, Mr. C. A. Kincaid sketched a literary and religious movement which, as he claimed, made possible the coming of Shivaji the Great, and stopped a large tract in India, the Deccan, from turning Mussulman. The beneficial effect of the sympathetic study by English officials in India of subjects such as the one under consideration was referred to in the discussion.

III.—Colonial Section.

Four excellent papers were read in this section: "Next Steps in Empire Partnership," by Mr. Percy A. Hurd; "Recent Developments in Jamaica: Internal and External," by Sir Sydney Olivier, K.C.M.G.; "The Forest Resources of Newfoundland," by Sir Daniel Morris, K.C.M.G.; and "Some Native Potentates and Colleagues," by the Right Hon. Sir William MacGregor, G.C.M.G.

Mr. Hurd took as his text some notable words of the Prime Minister of Australia, the Right Hon. W. M. Hughes, one of whose earliest speeches in England was made at a meeting of the Society in 1907. "We have," said Mr. Hughes, "arrived at the hour of our supreme trial and of our supreme opportunity." Mr. Hurd emphasised the necessity of our taking advantage of the "supreme opportunity" to perpetuate and enlarge the Empire partnership that has resulted from the war, and suggested numerous proposals by which he thinks the desired end can be obtained.

Just about thirty years ago the depressed condition of the cane-sugar industry brought the largest of our West Indian Colonies to the most difficult and critical stage of its economic history. The development of Jamaica which Sir Sydney Olivier discussed falls within these last thirty years. The two principal internal changes have been the development of small-holders' agriculture and the development of the banana trade. The external progress has been associated with the growth of the banana trade as between Jamaica and the United States, and in a less degree as between Jamaica and the United Kingdom, as well as by the colonisation of Central American countries by Jamaican labour.

The Prime Minister of Newfoundland, Sir Edward Morris, when on a visit to England two years ago, said: "Even to-day Newfoundland is not in the public eye, and it is only

occasionally that attention is drawn to its valuable resources and its great possibilities in the future." One reason why Newfoundland is not more in the public eye may be due to the fact that it has no Agent-General in this country. Doubtless Newfoundland will, in the circumstances mentioned by its Premier, be grateful to Sir Daniel Morris for consenting to make the public at home better acquainted with the principal industries of our oldest and nearest colony. He pointed out that since the war a new trade has sprung up—the production of pit wood—and Lord Northcliffe, one of the pioneers of the colony's thriving paper and pulp industry, informed the meeting that he had seen trenches in Flanders supported by pit props imported from Newfoundland.

With the exception of a celebrated African chief, the Alake of Abeokuta, the "native potentates" portrayed by Sir William MacGregor were men associated with his eminent services in the Pacific—Fijians, Tongans, Papuans, etc. He observed that in the rush of modern life we are too apt to overlook the important position such men occupy in the constitution and life of our "coloured Empire." Many of the members of these native races are, he claimed, our equals, and not a few of them superior to most of us. The Chairman (Viscount Bryce), in his comments on the paper, said that what Sir William MacGregor had told them had enlarged our ideas about those whom we are in the habit of calling barbarous or savage peoples.

IV.—Cantor Lectures.

This year there were two courses of Cantor Lectures. One of these was delivered before Christmas by Dr. Walter Rosenhain, and dealt with the subject of Optical Glass—a subject of special interest because of the increased demand for glass suitable for the construction of various appliances used in war, and also because the supply of all the best forms of such glass was cut off. As is well known, the great improvements which during the last twenty years have been made in optical glass have come from the Jena laboratory, where the researches of Abbe and his colleagues provided the makers of optical instruments with glasses in which high refractive power is combined with low dispersion, and high dispersive power with lower refractivity. Although the production of such glass has not been entirely neglected in this country, practically the whole of the supplies came from Germany. Dr. Rosenhain, in the three lectures which he gave on the subject, explained the special requirements for the production of such glass, gave a short history of its manufacture, and a full account of the present processes for making it.

The second course consisted of four lectures by Dr. J. Erskine-Murray, given in the month of May, on "Vibrations, Waves, and Resonance." Starting from the elementary idea of periodic motions, Dr. Erskine-Murray went on to discuss the various waves in ponderable matter and in the ether, leading up eventually to a summarised description of the principles of wireless telegraphy, and the methods adopted for what is known as tuning in such telegraphy. His lectures were illustrated by a considerable number of interesting and original experiments, though the present regulations with regard to the use of wireless telegraphy prevented any practical demonstration of it being given.

V.—Fothergill Lectures.

Two courses of lectures were given under this Trust. The first was by the Rev. G. Herbert West, D.D., on "National and Historic Buildings in the War Zone." Dr. West has made a special study of Gothic architecture in England and France, and was therefore able to show his audience a remarkably fine collection of lantern-slides dealing with the great buildings in Belgium and Northern France, so many of which have been destroyed by a ruthless and barbarous enemy. The first of his course of three lectures dealt specially with Belgian Architecture and History, the second with Gothic Architecture, French and English, and the third with French Mediæval Sculpture.

The second course consisted of three lectures by Mr. E. A. Reeves, the Map Curator of the Royal Geographical Society, and dealt with the subject of Surveying. Mr. Reeves gave a summarised, yet complete, account, historical and practical, of the various devices and means which have been employed for the production of maps down to the most recent modern instruments and methods of geographical surveying.

VI.—Juvenile Lectures.

As usual there were two Juvenile Lectures given during the Christmas recess, and the duty of delivering them was kindly undertaken by two members of the Council, who each undertook to give a single lecture. The first lecture was delivered by Professor John Millar Thomson, who illustrated his subject—Crystallization—with a singularly beautiful

series of experiments, the most remarkable of them being certainly those dealing with the crystallization of supersaturated solutions—an interesting subject of which Professor Thomson has made a special study.

The second lecturer was Mr. James Swinburne, and his subject the "Science of some Toys." The toys, the scientific nature of which was explained, included kites, sailing boats, spinning tops, and various musical instruments.

Both of these lectures were extremely interesting, and were well appreciated by large audiences. The Council desire to express their sense of the obligation which two of their members conferred upon the Society by generously providing two such attractive discourses.

VII.—Special War Lectures.

It was thought that members would be glad of an opportunity for gaining information about the manufacture of implements and materials for war, and the Council therefore arranged with the late Professor Vivian B. Lewes for the delivery during the recess of a short course of popular lectures on "Modern Munitions of War." Professor Lewes's special qualifications for dealing with the subject were well known, as he was for many years Professor of Chemistry at the Royal Naval College, Greenwich, while he had few rivals in his capacity for making a difficult scientific subject intelligible to a general audience. The Council deplore the fact that his death last October makes these lectures the last of the many services he has rendered to the Society.

The course consisted of three lectures delivered on three Wednesday afternoons in July and published in the *Journal* in August.*

The first lecture dealt with "Guns and Propellants," the second with "Mines, Shells, and High Explosives," and the third with "Poison Gases and Incendiary Bombs." The cost of the lectures was defrayed from the funds of the Fothergill Trust.

Tickets for the course, besides being given to Fellows for their friends, were also issued gratuitously to any persons interested in the subject who liked to apply to the Secretary. The result was that the lectures were attended by large and interested audiences, so that the experiment was fully justified. The necessary limitations under which information on such a subject could be published of necessity precluded Professor Lewes from dealing with its most recent developments, or, indeed, from stating anything not previously familiar to experts, but even under these difficult conditions he fully satisfied his hearers, and the lectures may be pronounced a brilliant success.

Professor Lewes's interesting course was supplemented by a very valuable lecture on field telephones which Mr. Charles R. Darling, Lecturer in Physics at the City and Guilds Technical College, Finsbury, very kindly offered to the Society. This was delivered on July 28th, the week following the last of Professor Lewes's course.

The telephones to which we are accustomed in civil life require, for various reasons, considerable modifications before they are suitable for use in the field. For this purpose special instruments have been devised, and the description of such instruments, and the methods of using them, formed the subject of Mr. Darling's very useful and practical lecture.

The lecture attracted a full audience, including a number of Army signallers and men being instructed in signalling connected with the various London units, to whom tickets had been issued. The number of the *Journal* containing the lecture has since been rather widely circulated, and the practical result has been the formation of various classes for instruction in field telephony in London and elsewhere.

VIII.—Albert Medal.

The Albert Medal of the Society for the current year has been awarded by the Council, with the approval of the President, H.R.H. The Duke of Connaught and Strathearn, K.G., to Professor Elias Metchnikoff, For.Mem.R.S., "in recognition of the value of his investigations into the causes of immunity in infective diseases, which have led to important changes in medical practice, and to the establishment of principles certain to have a most beneficial influence on the improvement of public health."

The discoveries of Professor Metchnikoff in regard to the nature of immunity to infective diseases have contributed, more than the work of any other living man, to the control of such diseases, and to the consequent improvement in the health of great European populations, and the safeguarding of those who have to face the dangers of bacterial infection, whether on the battlefield or as pioneers in tropical climates.

For many years, as Professor of Zoology at Odessa, he was an ardent student of lower forms of life. It was by the study with the microscope of the cell activities of sponges and

* See *Journal*, August 6th, 1915, Vol. LXIII. p. 821.

transparent marine organisms that he arrived at his discovery of Phagocytosis.

These researches into the development and metamorphoses of invertebrates prepared the way for his great discovery, as he was led by the observation of the action of the mesoderm cells in the embryonic organs of echinoderms to the knowledge that the white blood-cells or phagocytes devour the invading microbes in vertebrates also, and he was thus able to show the universal applicability of his generalisation.

Professor Metchnikoff's services to zoology and pathology are of world-wide repute, and have already been recognised by the award of the Nobel Prize for Medicine, and of the Copley Medal of the Royal Society. In announcing the last-named award, Lord Rayleigh concluded an admirable summary of Metchnikoff's investigations with the words: "It is not too much to say that the work of Metchnikoff has furnished the most fertile conception in modern pathology, and has determined the whole direction of this science during the last two decades."

It may be not amiss to add, on the authority of one of his intimate friends, and the one best qualified in this country to express an opinion at once on the value and the intention of his life's work, that his definite purpose has always been philanthropic, and that he has consistently striven to arrive at a true understanding of infective disease with the aim and object of enabling humanity to control it.

IX.—Medals for Papers.

The Council decided that the number of medals for the papers read before the Society during the present session should be reduced to four in all—two for papers read at the Ordinary Meetings and one each for the Indian and the Colonial Sections.

The following awards have been made:—

At the Ordinary Meetings:—

J. Arthur Hutton, "The Effects of the War on Cotton-Growing in the British Empire."

George Percival Baker, "East Indian Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

In the Indian Section:—

James MacKenna, M.A., I.C.S., "Scientific Agriculture in India."

In the Colonial Section:—

Sir Sydney Olivier, K.C.M.G., "Recent Developments in Jamaica: Internal and External."

Of recent years it has been the practice that no medals should be awarded to readers of papers who had previously received medals from the Society. Acting on this rule the Council were precluded from considering the following papers:—

At the Ordinary Meetings:—

Professor J. A. Fleming, D.Sc., F.R.S., "The Organisation of Scientific Research."

Charles R. Darling, A.R.C.Sc.I., F.I.C., "Optical Appliances in Warfare."

In the Indian Section:—

Colonel Sir Thomas Hungerford Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "The Romance of Indian Survey."

Professor Wyndham R. Dunstan, C.M.G., M.A., LL.D., F.R.S., "The Work of the Imperial Institute for India."

In the Colonial Section:—

Sir Daniel Morris, K.C.M.G., M.A., D.C.L., D.Sc., F.L.S., "The Forest Resources of Newfoundland."

The Council, however, desire to express their high appreciation of these papers.

X.—Owen Jones Prizes.

These prizes have now been awarded annually for thirty-seven years since the year 1878 on the results of the annual competition of the Science and Art Department, and its successor, the Board of Education. The awards have always been made on the recommendation of the examiners for the "National Competition."

Six prizes were offered for competition in 1915, each prize consisting, as in previous years, of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the "Grammar of Ornament," by Owen Jones, and the Society's Bronze Medal.

A list of the successful candidates has already appeared in the *Journal*.*

The Council had hoped to renew the offer for the current year, but a difficulty arose. The Board of Education decided to suspend the "National Competition," in connection with which the Owen Jones prizes have always been awarded, and so that competition was no longer available as a basis for the award of the prizes in 1916. The prizes under the terms of the Trust are only open to "Students of the Schools of Art," and though the Board expressed their readiness to assist the Society, it appeared that there was no convenient arrangement under which the proper adjudication could be carried out.

* See *Journal*, July 16th, 1915, Vol. LXIII. p. 773.

In these circumstances the Council felt that they had no alternative but to suspend the offer of the prizes for the year, in the hope that later on some suitable way may be found for carrying out the conditions of the Trust.

They regret that the series of awards, which have been so successfully carried out for a long period of years, should be interrupted. They realise that the Owen Jones prizes have been greatly appreciated by the numerous students who have received them, and that they have served as a useful stimulant to the study of decorative design. They hope, therefore, that before long it may be possible to devise some suitable scheme for their continuance.

XI.—North London Exhibition Trust.

For some years past the interest on the sum of £157, the surplus of the North London Exhibition held in 1864, has been devoted to the award of prizes to students of the Artistic Crafts Department in the Northampton Polytechnic Institute, Clerkenwell. At present an annual sum of £5 is placed at the disposal of the Governors of the Institute. This year one prize of £1 10*s*. was awarded in the senior section of the Department, and three in the junior section, one of £2, and two of 15*s*. each. The awards were made on the recommendation of Mr. Alan S. Cole, C.B.

The names of the successful candidates have already appeared in the *Journal*.*

XII.—Peter Le Neve Foster Prize.

It was announced in last year's Report that Mr. Reginald Le Neve Foster had presented the Society with a donation of £140 for the purpose of founding a prize in commemoration of his father, Mr. Peter Le Neve Foster, who was Secretary of the Society from 1853 to 1879. The original gift of £100 was made up to £140 so that an annual sum of £5 might be available.

The Council after careful consideration decided to add a Silver Medal, and to offer it with a sum of £10, being the amount of two years' interest, for an essay on "Zinc, its Production and Industrial Applications." An announcement to that effect was published in the *Journal* in August,† and December 31st was fixed as the date by which the essays were to be sent in. By that date twelve essays were received, and these were referred to a committee of judges appointed by the Council. On their recommendation the prize was awarded to Mr. J. C. Moulden, A.R.S.M., M.Inst.M.M., of Seaton Carew, Co. Durham. Honourable mention was also awarded to Mr. Ernest Alfred Smith, A.R.S.M., M.Inst.M.M., Deputy Assay Master of the Sheffield Assay Office, for his essay.

The adjudicators reported that the two essays above mentioned were distinctly superior to the others, several of which, nevertheless, were of interest and value. An essay by Mr. Ramji Das Vaishya, of Gwalior, Central India, contained a good deal of information with regard to the production and utilisation of the metal in the East Indies.

The prize essay, as mentioned on a previous page, was read in abstract at the Ordinary Meeting of the Society held on May 24th. Dr. Dugald Clerk, the Chairman of the Council, presided, and presented the medal to Mr. Moulden. The paper was published in two successive numbers of the *Journal*, May 26th and June 2nd.

XIII.—Examinations.

It was a matter of regret, though not of much surprise, that the number of entries for the examinations in the two divisions again showed a diminution. In the year 1914 the numbers examined reached the high total of 37,993, practically 38,000. The diagram, on which the figures since the year 1880 have been plotted out, shows an absolutely continuous ascent up to the year 1911, in which year the numbers had reached 28,644. There was then a fall for two years down to 28,400, which was caused by special circumstances well recognised at the time, and then a sudden upward ascension to the number above mentioned.

It was anticipated that in consequence of the new arrangements under which a double examination was held, instead of all the examinations being held at one period of the year, the rate of increase would have been still more rapid. These calculations, however, were upset by the war, and there was last year a considerable diminution in numbers. It was certain that a further loss would be felt this year, but there was some hope that the falling-off might have been comparatively small, and this was encouraged by the fact that, compared with last year, the entries for the first division of the examinations, held in April last, showed an increase of some 1,500 over last year. For the second division however, held in May and June, the falling-off was very large and amounted to nearly 7,700.

* See *Journal*, January 21st, 1916, Vol. LXIV. p. 173.
† See *Journal*, August 13th, 1915, Vol. LXIII. p. 837.

In all there were this year 25,968 entries, whereas last year there were 32,129—a total decrease of 6,161. Of these 4,549 were from London—a decrease of 1,933—and 21,419 from the provinces—a decrease of 4,228. The decrease is obviously due to the same causes as last year, the calling to the army of men just of the age of our candidates, and the absorption of others, young women as well as men, to take the places of the new soldiers. This year the decrease has been accentuated by the fact that many provincial authorities have abandoned their evening classes altogether.

The financial result of this was that the Society's balance-sheet for the year shows the cost of the examinations as £3,831 against examination fees received of £2,796, or a deficiency of £1,035. This, however, as explained in the paragraph dealing with Finance, is not a loss on this year's working, since the receipts are those for 1916, and the amount on the other side represents the payments on the previous year's examinations. The receipts, therefore, are diminished in consequence of the reduced number of this year's candidates, while the payments are those incurred for the larger number examined in 1915. It is not possible to speak very definitely, as the amounts have not yet been fully worked out; but it seems almost certain that the actual cost of this year's examinations will be about met by the amount paid in fees.

The Council were reluctant last year to suggest any increase in the fees, or to adopt any other method of reducing the present loss on the examinations; but it is certain that some steps will have to be taken with regard to the future, as the Society cannot reasonably be called upon to defray a considerable annual deficiency. It must, however, be remembered that in the event, as may certainly be anticipated, of the numbers after the war resuming their former average, there would be at once an apparent profit on the working of years showing a considerable increase.

The usual money prizes which are awarded in each subject were abandoned this year, but the liberality of the Worshipful Company of Clothworkers, for whose consistent support for many years the Society is so greatly indebted, enabled the usual medals to be provided. These medals are very highly esteemed by the successful candidates, but it is believed that the disappearance of the money prizes will not really be much felt.

It is interesting to be able to report that it was found possible to provide examinations for some of the interned prisoners at Ruhleben, in Germany, and at Groningen, in Holland; and in both cases the usual fees were remitted.

In response to a suggestion from one of the local centres, an examination in English was arranged for Belgian refugees, and this proved extremely successful, for in all nearly 600 candidates worked papers. In this case it was thought desirable to charge the usual fees. But the work of setting the papers and marking the answers was done gratuitously, and the fees usually paid to the examiner will be handed over to a Belgian charity.

For a good many years past the Society has held an examination in Russian, but the number of candidates has been extremely small. This year, however, a special notice was sent round to the various schools where classes in the Russian language had lately been established, and the result has been that no less than 160 candidates entered for the examinations in this language.

XIV.—Viva Voce Examinations in Modern Languages.

Up to the present date seventeen examinations have been held this year in London and Manchester, but it is doubtful if any more will be arranged before next spring.

At these examinations 380 candidates presented themselves in the following subjects: French, 259, of whom 212 passed (83 with distinction); German, 34, of whom 29 passed (20 with distinction); Spanish, 15, of whom 12 passed (2 with distinction), and Russian, 19, of whom 16 passed (2 with distinction).

There was also a special examination in English for Belgian refugees in this country; 53 candidates were examined, of whom all but one passed, 34 obtaining distinction.

It will be noted that Russian appears for the first time on the list of subjects.

XV.—Journal.

During the past year it has been found necessary to make serious alterations in the *Journal* with a view to increased economy in its production. In August last it was decided to abandon the coloured cover in which the *Journal* has been published ever since November, 1872, and to substitute a white one. The cost of printing was thereby considerably reduced. The reduction was also justified by the considerable loss in the advertisements, the

revenue from which was greatly diminished by the war.

The suggested abolition of the halfpenny rate of postage in October threatened to make a further addition to the cost of the distribution of the *Journal*. The Council, therefore, after very careful consideration, decided that it might be necessary to make very considerable alterations in the publication of the *Journal*, and they had practically determined to issue it fortnightly instead of weekly, and perhaps during the recess but once a month. The decision, however, of the Government not to make any alteration in the newspaper rates rendered these changes unnecessary, and the Society has been able to continue the weekly publication of the *Journal*, which was commenced in 1852.

In the spring of the current year the restrictions on the supply of paper caused further difficulties, and it was feared that it might be impossible to procure sufficient paper for the *Journal* even at an enhanced price. These difficulties, however, were overcome, and the Council trust that the regular publication of the weekly *Journal* has been secured at all events for a considerable time to come. Still, it was found absolutely necessary to restrict the size of the *Journal* as much as possible, and since the middle of March it has been cut down to the smallest possible size. Of necessity much interesting matter has had to be omitted, and for the last three months the *Journal* has contained very little except the bare record of the Society's Proceedings. All these, however, have been regularly published, though in a few cases there was a little delay in the appearance of certain of the sectional papers. This enforced reduction of a most important part of the Society's work has been a matter of deep regret to the Council. But they feel certain that the Fellows generally will approve of their efforts to carry on the regular issue of the Society's official organ under exceptional and adverse circumstances.

XVI.—Afternoon Meetings.

Before the commencement of the session the Council determined that, having regard to the darkened condition of the streets during the winter, it would be desirable, at all events as a tentative measure, to alter the hour of the Society's meetings. An announcement was accordingly made that they would, in the early part of the session, be held in the afternoon. The change seems to have commended itself to the great body of the Fellows, as there were almost no objections, and many of the Fellows expressed themselves in favour of it. It has therefore been continued during the whole of the session. The wisdom of the alteration has been shown by the fact that the attendance has not at all fallen off—in fact, the attendance at the meetings appears to have been, if anything, above the usual average.

XVII.—Society's Staff.

Three members of the Society's clerical staff have been called up for service—A. G. Toye, H. T. Broad, and J. G. Morris. The Council have felt justified in continuing to pay in each case such a proportion of the original salary as would suffice, with army pay and allowance, to bring it up to the usual amount. All the other members of the Society's staff are over military age or are medically unfit. F. A. Scorey, for some years assistant to the office-keeper, who had been in the army and had served in the South African War, volunteered last year, and was seriously wounded in Gallipoli. In his case also a suitable allowance was made.

The staff was still further reduced by the fact that the Assistant Secretary (Mr. G. K. Menzies) has been seriously ill for the past four months. It will therefore be seen that the Society's work has been carried on under circumstances of considerable difficulty.

XVIII.—Conjoint Board of Scientific Societies.

In February last the Council received a communication from the Royal Society stating that that Society proposed to form a Conjoint Board of Scientific Societies to be composed of representatives of twenty-six learned Societies, of whom the Royal Society of Arts was one.

The objects of the Board were stated as follows:—

"Promoting the co-operation of those interested in pure or applied science, supplying a means by which the scientific opinion of the country may, on matters relating to science, industry, and education, find effective expression; taking such action as may be necessary to promote the application of science to our industries and to the service of the nation; and discussing scientific questions in which international co-operation seems advisable."

The Society was invited to nominate two delegates, and the Council thereupon appointed Sir Philip Magnus and the Secretary (Sir Henry Trueman Wood). The delegates have held several meetings, and have formulated a con-

stitution for the proposed Board, which has been sent round to the constituent societies for their approval.

XIX.—New Council.

The following Vice-Presidents retire by seniority: Sir William Abney, Earl Brassey, Sir Mortimer Durand, Sir Thomas Holdich, and Sir Henry Miers. Mr. Carmichael Thomas also retires that he may resume the position of Treasurer. In their place the Council recommend for election: Sir William Duke, K.C.S.I., K.C.I.E., a Member of the Council of India; Mr. Edwin Landseer Lutyens, A.R.A., the well-known architect; Sir Philip Magnus, M.P., who has served for some time on the Council; Lord Northcliffe; Lord Sanderson, who was Chairman of the Council from 1911 to 1913, and acted last year as Treasurer; and Mr. Alan A. Campbell Swinton, who has served for the last four years on the Council.

The four members of Council retiring by seniority or by non-attendance are: Lord Aldenham, Sir Steyning Edgerley, Sir Philip Magnus, and Mr. Campbell Swinton. In their place the Council recommend Sir George T. Beilby, LL.D., F.R.S., the eminent chemist and metallurgist, to whom the Society is much indebted for the assistance he gave in adjudicating on the essays on Zinc sent in for the Le Neve Foster Prize, Mr. Edward Dent, an old Fellow of the Society who has long been a member of the Committee of the Colonial Section, Sir Robert Hadfield, D.Sc., F.R.S., and Sir H. Capel Holden, K.C.B., F.R.S. Sir Robert Hadfield and Sir Capel Holden have held office on the Council in former years.

XX.—Obituary.

The death of Lord Alverstone in December last deprived the Society of one who had long taken a most active interest in its welfare. On the death of King Edward VII., in 1910, he was elected President of the Society, on the Council of which he served from 1883 down to the time of his death. Until the commencement of the illness which terminated fatally, he had been a regular attendant at the meetings of Council, and certainly no one of recent years took a more active interest in the Society's concerns.

Lord Ridley served on the Council for a year, and on one occasion presided at one of the Society's meetings. Sir Colin Scott-Moncrieff joined the Society in 1895, and served as a Member of Council from 1908 to 1910; he was a member of the Indian Section Committee from the time of his election on the Council until his death.

Sir Andrew Noble, who first joined the Society in 1882, received the Albert Medal in 1909. Sir Thomas Fowell Buxton was a member of long standing, and for many years served on the Committee of the Colonial Section. In 1875 he presided at the meeting when the Rev. Horace Waller read a paper on Livingstone's Discoveries. Professor Vivian Lewes was well known to a very large number of Fellows, for he was one of the most popular lecturers who ever appeared on the Society's platform. Sir Patrick Playfair was a member of the Committee of the Indian Section. Sir Hay Frederick Donaldson, the eminent Superintendent of the Royal Ordnance Factories, was one of those who with Lord Kitchener were drowned in H.M.S. "Hampshire" on the 5th of the present month. Mr. Elmer Lawrence Corthell, the well-known American engineer, was a Fellow of some twenty-five years' standing, and always took a warm interest in the Society's welfare. Lord Glantawe (Sir John Jones Jenkins) was a member of the Society since 1873. Sir Michael Nairn was a very old member, as he joined the Society in 1866. Sir Thomas Jackson and Sir William Mitchell were both elected in 1900. Mr. Matthew Hamilton Gray was a member of a family many members of which were connected with the Society, his brother Robert having served for many years on the Council; but he himself never took any active part in the Society's work. Mr. George Wheeler, who was elected in 1903, bequeathed a sum of £100 to the Society on the condition that the money should be expended in paying the fees of a number of life Fellows to be nominated by his executors.

Obituary notices of all the above, and of other Fellows who have died during the past year, will be found in the columns of the *Journal*.

XXI.—Finance.

The annual statement of receipts and expenditure was published—in accordance with the usual practice—in the *Journal* last week. It shows the revenue and expenditure for the financial year ending May 31st last, the assets and liabilities of the Society, its investments and the trusts standing in its name.

That the result of the year's working should show a diminished balance is not to be

wondered at, and indeed the Fellows may congratulate themselves that the deficiency is no larger. But for the falling-off in the number of candidates entering for the Society's examinations, it would hardly have existed at all and the difference between the two sides of the account would have been negligible. The statement made in last year's Report may here be repeated, that the apparent heavy loss on examinations is not a loss on the year's working, but is the result of the Society's financial year not coinciding with the calendar year. The examination receipts are those for 1916, while the payments are those for 1915.

Apart from this one item the financial statement is by no means an unsatisfactory one under present conditions. The annual subscriptions have naturally fallen off, but the difference is nearly balanced by a considerable increase in life contributions, so that the total deficiency in subscriptions is under £70 as compared with last year. This increase in life subscriptions is partly due to a legacy from the late Mr. George Wheeler, who left the Society £100 on condition that five of his friends were to be elected Life Fellows. Apart from this, however, the amount of life subscriptions was about £100 above that of last year.

The Society's dividends from its investments have of course fallen in consequence of the heavy tax, and the *Journal* advertisements, once a source of considerable revenue, now produce very little.

It may be mentioned that the amount of 2½ per cent. Consols standing in the Society's name, £1,650 12*s*. 6*d*., was in the autumn of last year converted into £1,100 8*s*. 4*d*. 4½ per cent. War Loan.

THE CHAIRMAN (Dr. Dugald Clerk, F.R.S.) moved the adoption of the report, which showed the activities of the Society during the past year, and was on the whole, he considered, very creditable. They were greatly indebted, he said, to Sir Henry Wood for the preparation of such an excellent and full report of the Society's work.

COLONEL SIR THOMAS HOLDICH, K.C.M.G., K.C.I.E., C.B., D.Sc., had much pleasure in seconding the adoption of the report, which illustrated the manner in which the Society had adapted itself to the new and unexpected conditions of the present time. He thought it was a matter for congratulation that they had been able to carry their activities so far afield as to the Ruhleben Camp in Germany, where some of our unfortunate countrymen were interned, and thereby to lighten, he hoped, to a certain extent the pains and penalties of their imprisonment there. On the whole he thought the report was most satisfactory, and though they deplored the decrease in revenue and in the number of Fellows, still he did not imagine that there was another public institution in the kingdom which had weathered the storm better than the Royal Society of Arts.

The adoption of the report was then agreed to.

THE CHAIRMAN proposed a cordial vote of thanks to Sir Henry Trueman Wood, the Secretary, and the other officers of the Society for their services. The Society, he said, had gone through a very trying time, and it was surprising how well Sir Henry Wood, with his depleted staff, had managed, He was glad to say that Mr. Menzies, the Assistant Secretary, was now on the way to recovery. He had the greatest pleasure in proposing the vote, as Sir Henry Wood and his staff thoroughly deserved their most hearty thanks—indeed, the position of the Society was mainly due to their labours.

The vote of thanks was seconded by Mr. PETER MACINTYRE EVANS, and supported by Mr. ERNEST A. WEST.

THE SECRETARY returned thanks for this expression of continued confidence in himself and in the other officers of the Society. Owing to the regrettable absence of the Assistant Secretary through illness, his duties had considerably increased during the past four months. He would, however, like to bear testimony to the special help which two members of the staff—Mr. George Davenport and Mr. J. H. Buchanan—had rendered him in connection with the Examinations and the editing of the Society's *Journal*. This was the forty-fourth annual meeting since he first entered the service of the Society, and with the exception of 1893, when his duties with the Royal Commission took him to Chicago, he thought he had been present on every occasion.

The ballot having remained open for half an hour, and the scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. [The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.]

PRESIDENT.

H.R.H. The Duke of Connaught and Strathearn, K.G.

VICE-PRESIDENTS.

Sir George Ranken Askwith, K.C.B., K.C., D.C.L.
Right Hon. Arthur James Balfour, O.M., LL.D., D.C.L., M.P., F.R.S.
Sir Steuart Colvin Bayley, G.C.S.I., C.I.E.
Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.
Lord Blyth.
Sir William Duke, K.C.S.I., K.C.I.E.

Lord Faringdon.
Lord Inchcape, G.C.M.G., K.C.S.I., K.C.I.E.
Edwin Landseer Lutyens, A.R.A., F.R.I.B.A.
Major Percy A. MacMahon, R.A., LL.D., Sc.D., F.R.S.
Sir Philip Magnus, M.P.
Right Hon. Lord Moulton, K.C.B., M.A., LL.D., F.R.S.
Lord Newlands, LL.D.
Duke of Norfolk, K.G., G.C.V.O.
Lord Northcliffe.
Hon. Richard Clere Parsons, M.A.
Ernest H. Pooley, M.A., LL.B.
Lord Sanderson, G.C.B., K.C.M.G.
Alan A. Campbell Swinton, F.R.S.
Professor J. M. Thomson, LL.D., F.R.S.
Sir John Wolfe-Barry, K.C.B., LL.D., F.R.S.

ORDINARY MEMBERS OF COUNCIL.

Sir George Thomas Beilby, LL.D., F.R.S., F.I.C., F.C.S.
Dugald Clerk, D.Sc., F.R.S.
Alan S. Cole, C.B.
Edward Dent, M.A.
Peter MacIntyre Evans, M.A.
Sir Robert Abbott Hadfield, D.Sc., D.Met., F.R.S.
Colonel Sir Henry Capel Lofft Holden, R.A., K.C.B., F.R.S.
Major Francis Grant Ogilvie, C.B., LL.D.
Sir Robert William Perks, Bt.
Sir Boverton Redwood, Bt., D.Sc., F.R.S.E.
John Slater, F.R.I.B.A.
James Swinburne, F.R.S.

TREASURERS.

Carmichael Thomas.
William Henry Davison, M.A.

SECRETARY.

Sir Henry Trueman Wood, M.A.

On the motion of the CHAIRMAN a vote of thanks to the scrutineers was carried unanimously.

MR. CARMICHAEL THOMAS proposed a very hearty vote of thanks to the Chairman. It hardly seemed a year, he said, since the Chairman took the office, but he felt sure that every one would agree that he had proved a most excellent Chairman, and they were all very sorry indeed that his year of office had expired.

SIR ROBERT PERKS, Bt., said he had very much pleasure in seconding the vote of thanks. He had been much struck with the versatility of the Chairman, for there was hardly a subject brought forward at the meetings of which he did not seem to be a master.

THE CHAIRMAN, in acknowledging the vote of thanks, said that this last year had been a very interesting one for him, and that he had thoroughly enjoyed his work with the Society.

The meeting then adjourned.

GENERAL NOTES.

THE LA CEIBA TREE.—According to a report by the United States Consul at Ceiba, the tree known as la ceiba is one of the dominating features of the landscape in the Ceiba district of Honduras. It rises to a height of 70 or 80 ft. before branching, and then a broad top spreads out like a huge umbrella. The trees are commonly 6 ft. or more in diameter, but the wood is soft and not considered valuable for lumber. It is white and many persons think it would be valuable for paper pulp. The tree bears a silky cotton, which is used to some extent for stuffing cushions.

POISON GASES IN WAR.—Dr. A. C. Cumming, Lecturer in Chemistry at the University of Edinburgh, recently gave an address on poison gases, with illustrative experiments, in the Morningside Church Hall, Edinburgh. The use of gases in warfare was, he said, no new thing, but in most civilised countries it was regarded as barbarous and inhuman, and had consequently fallen out of favour. In some of the early attacks the Germans had used bromine freely. Soon after the war began it was practically unobtainable in this country, whereas so much of it was produced at Stassfurt that the Germans had more of it than they could use or sell. There was good reason to believe that the practice of using poison gas was losing favour with the Germans.

UTILISATION OF WASTE.—It is pointed out, in a paper recently published by the Bureau of Mines, that within the past five or six years marked progress has been made in Europe in the utilisation of various kinds of refuse material not ordinarily given much consideration. The manufacturers of gas-producers report the successful use of a large variety of fuels, including wood shavings, wood blocks, sawdust, excelsior, coffee husks, rice husks, coconut shells, straw, and spent tan bark. The figures on fuel consumption reported by the manufacturers are about as follows: With reasonably dry wood (say mixed oak, ash, and elm) the consumption has been as low as 2 lb. per brake h.p. hour; with sawdust the consumption averages 3½ lb. brake h.p. hour; and with spent tan bark containing 50 per cent. moisture, it is about 4½ lb.

DETERMINATION OF CARBON IN STEEL.—The direct combustion method for determining carbon in steel and iron has been tested at the United States Bureau of Standards, to ascertain whether a higher combustion temperature would give higher carbon percentages. The results of the work, published in Technologic Paper No. 69 of that Bureau, show that, even when the temperature is above 1450° C., which exceeds the fusion temperature of the iron oxides formed, the carbon is only about one-hundredth per cent. higher than that obtained by the direct combustion method as usually practised.

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FRIDAY, JULY 7, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

EXAMINATIONS.

The results of the Intermediate (Stage II.) Examinations, held from April 10th-17th, were posted to the centres concerned on June 30th. The results of the Elementary Stage, held at the same time, will be sent out about the middle of the current month.

INDIAN SECTION.

Thursday afternoon, June 29th, 4.30 p.m.; THE RIGHT HON. AUSTEN CHAMBERLAIN, M.P., Secretary of State for India, in the chair. A paper on "The Sikhs" was read by SIRDAR DALJIT SINGH, C.S.I., Member of the Council of the Secretary of State for India.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, June 1st, 1916; THE RIGHT HON. LORD ISLINGTON, P.C., G.C.M.G., D.S.O., Under-Secretary of State for India, in the chair.

The paper read was—

THE WORK OF THE IMPERIAL INSTITUTE FOR INDIA.

By PROFESSOR WYNDHAM DUNSTAN, C.M.G., M.A., LL.D., F.R.S.,
Director of the Imperial Institute.

In response to the invitation of the Indian Section of the Royal Society of Arts, I shall endeavour in this paper to give some account of the work of the Imperial Institute for India during the last twenty years, but more especially during the thirteen years in which the Institute has been a Government institution.

The initial operations of establishing and equipping the Imperial Institute for the great work which was originally planned for it occupied the first governing body several years after its formal opening by Queen Victoria in 1893, during which time the Institute was seriously handicapped for want of funds for its current expenditure, and the unsuccessful attempt to provide these funds by popularising the Institute is too well known to need more than a passing comment. This plan of providing income failed in its object before the real foundation of the work of the Institute had been laid. The princes and people of India had responded generously to the appeal of H.R.H. the Prince of Wales, afterwards King Edward VII., for subscriptions to the general building fund, and from these subscriptions, in great part, a small and wholly inadequate endowment fund was formed. The Government of India made no contributions to the General Fund, but soon after the opening of the building by Queen Victoria, in 1893, an Indian Section was formed to be devoted to the exhibition of Indian raw materials and industries, which was subsequently placed in charge of a separate Indian Committee, and with an annual contribution from the Government of India by means of which a special Indian Curator was appointed as the executive officer of this committee. On the establishment of the Scientific and Technical Research Department, in 1896, the Government of India made a small contribution to the support of this department of £100 a year, which some years later was increased to its present amount of £200 a year, and with this extremely modest endowment for Indian research a vast amount of useful work has been done. In 1906 the Indian Section Committee was discontinued and the management of the Indian Section was merged in the general administration of the Institute, and at the same time the contribution of the Government of India to the support of the Indian Section was reduced.

The responsibility of the Imperial Government

for the management of the Imperial Institute dates from 1903, when I became Director, and the Institute passed to the control of the Board of Trade under the Act of that year.

The present is an opportune time to consider in brief review the work which has been accomplished for India in that period of thirteen years, since a new Act has just been passed by which the control of the Imperial Institute has been transferred to the Colonial Office, and the actual management of the Institute vested in a large and representative Executive Council, on which India will occupy an important place.

The Indian Collections of the Imperial Institute.

The Indian Collections of the Imperial Institute, which have been completely reorganised in recent years, constitute the Indian Section of the Public Exhibition Galleries. They include a representation of the important raw materials of India, illustrations of its chief industries and their results, tabular information and diagrams respecting Indian trade and commerce, maps, pictures and photographs of its cities and industries. All important exhibits are provided with descriptive labels which enable the visitor at once to gain general knowledge of the sources and uses of the materials shown.

The contributions made by the Government of India to these collections in recent years have not been numerous, partly because there is no longer an officer in India to whom can be delegated the duty of collecting the material required, so that additional exhibits have to be obtained separately from the various Provinces and Departments in India. Fortunately, however, private contributions have done much towards making the Indian Section representative of the resources and industries of modern India. To the interest and generosity of Their Majesties the King and Queen are due some hundreds of illustrations of Indian industries in all materials, as well as photographs and pictures of India, including many interesting souvenirs of Indian loyalty.

The principal Indian fibres are shown, together with native manufactured materials, accompanied by labels descriptive of the origin, composition and uses, actual and potential, of these fibres. The great Indian tea industry is illustrated by specimens of tea of various grades, maps showing the tea areas of Southern India, photographs of tea gardens and factories, statistics of production and destination, and printed statements explanatory of the production and preparation of tea in India. The industries of silk, opium, lac, and metal-working are similarly illustrated and explained, whilst all the raw materials of India which find their way into European commerce are also shown and explained. The principal minerals of India are likewise shown and their composition and uses described.

The value of the Indian Collections cannot be over-estimated, and it is hoped that in future they may be further augmented. In furnishing material for research they have proved of great service, not merely to the scientific investigator, but to the commercial man in search of materials for industrial purposes. Their special value in this connection is enhanced by the fact that the commercial inquirer can also find at the Imperial Institute full information respecting the sources, composition, and uses of raw materials, and that he can, through the Institute, obtain particulars as to supplies and also trial consignments for manufacturing purposes.

The fear has often been expressed that the position of the Imperial Institute at South Kensington would be a serious drawback to its utility for business purposes. Whatever drawbacks there may have been in early days when means of communication were not as numerous or as convenient as they now are, the record of the operations of the Institute in the past decade is sufficient proof that its geographical position has not seriously interfered with the prosecution of a very large body of important work in which manufacturers and merchants have been intimately concerned, and at the present time the number of inquiries received from the same sources are such as to severely strain the capacity of the staff allotted to this work. So far as India is concerned, the chief purpose in view is to interest the British manufacturer in her raw materials, and in those cases in which a visit to London from manufacturing centres in the provinces is needed, the actual *locale* of the Institute is of small importance if the information required is obtained. Each year there are nearly a quarter of a million visitors to the public galleries, few of whom are mere sightseers.

In reorganising the Indian Section, one object which has been kept steadily in view is to render the Indian Collection intelligible and attractive to the general public, whose interest in the countries of the Empire has so greatly increased in recent years, and to enable schools to use this unique representation of modern

India in connection with the teaching of the commercial geography of the Empire. In order to provide more effectively for this important use of the Indian Collections, it has been part of the duty of the superintendent of the section to conduct a large number of parties from schools through the Indian Section and explain the principal exhibits. The demand for this assistance, both on the part of the general public as well as schools, has now become so great as to require the services of a special demonstrator. For want of funds no permanent arrangement is possible at present, but a beginning has been made with a series of short illustrated lectures on the countries of the Empire, followed by demonstrations in the corresponding sections of the Public Exhibition Galleries, and the number of requests for admission shows that in this way the Indian and Colonial Collections of the Imperial Institute can play an important part in a much neglected branch of education. This scheme has more recently been supplemented by a further series of short illustrated lectures on "Our Tropical Industries" (tea, coffee, rubber, sugar, etc.), illustrated by the collections in the Public Galleries.

Scientific and Technical Research Department.

Some of the earliest work of the Scientific and Technical Research Department was on Indian problems, to which I shall refer in detail hereafter. This department, which has been very greatly extended since its inception, includes research laboratories and technical work-rooms with a staff of trained workers in the several aspects of the utilisation of raw materials for industrial purposes. Of the important work accomplished by this department for India I shall speak presently. At this point it is only necessary to say that whilst many special investigations of a scientific character have been carried out, *e.g.*, on Indian drugs and oils, the chief Indian researches have been technical and commercial, and of a character which renders it desirable that they should be carried out in whole or in part in this country rather than in India.

Technical Information Bureau.

Ever since the department was started a most important part of its work has been, in addition to conducting researches, to collect and critically collate all published information respecting the production and industrial uses of raw materials, and it has gradually come to be recognised as a central clearing-house for information of this character. Merchants and manufacturers in this country, as well as producers in India and the Colonies, have applied in increasing numbers for information on these subjects. In order to be in a position to deal more effectively with such inquiries, a special branch of the department was formed in 1914, whose business it is, in collaboration with the Staff of the Scientific and Technical Research Department, to collect and distribute technical information. Since the war this branch, known as the Technical Information Bureau, has been very full of work, and has not only dealt with a large number of inquiries as to Indian materials and their possibilities, but has taken the initiative with British manufacturers and merchants in bringing to their notice important Indian materials which await a new market.

The three principal agencies for promoting the Indian work of the Imperial Institute, the Indian Collections, the Scientific and Technical Research Department, and the Technical Information Bureau, have now been generally described, and it is only necessary to refer to the library and map rooms, which are important auxiliaries to this work, and to the *Bulletin of the Imperial Institute*, which has played a conspicuous part in making known throughout the Empire the results of researches conducted at the Institute, and the records of progress in the various aspects of the production and utilisation of commercial and economic materials. For some years the *Bulletin*, in an enlarged and extended form, has been published for the Institute by Mr. John Murray, and shows an increasing circulation throughout the world. A glance at the contents of the thirteen published volumes will show how much attention has been given to Indian subjects of importance.

I now propose to describe in some detail the results of the more important work which has been accomplished for India at the Imperial Institute, and especially that carried on by the Scientific and Technical Research Department, and its branch the Technical Information Bureau. Before doing so, I will show, as lantern-slides, some views of the various departments of the Institute:—

1. Imperial Institute.
2. Imperial Institute: Corner of Indian Pavilion.
3. Imperial Institute: Indian Gallery.
4. Indian Section: Jute exhibit.
5. Indian Section: Drug exhibit.

6. Indian Section: Mineral exhibit.
7. Indian Section: Leather and Dyes exhibit.
8. Imperial Institute Laboratories: Rubber Testing Room.
9. Imperial Institute Laboratories: Oils, Gums, Resins, Rubber, etc.
10. Imperial Institute Laboratories: Instrument Room.
11. Imperial Institute Laboratories: Fibres, Foodstuffs, Essential Oils, etc.
12. Imperial Institute Laboratories: Drugs and Essential Oils.
13. Imperial Institute Laboratories: Minerals I.
14. Imperial Institute Laboratories: Minerals II.

The Work of the Scientific and Technical Research Department.

The Scientific and Technical Research Department of the Imperial Institute has had as its chief purpose the investigation of economic products and raw materials of the Empire, with a view to their utilisation in industries and commerce. India had at the time of the initiation of this department an officer called the Reporter on Economic Products, whose principal duty was to make a survey of the economic products of India and to take steps to secure their investigation, and the introduction to commerce of those not fully or at all utilised.

The work of this officer, Sir George Watt, was naturally closely connected with that of the Scientific and Technical Research Department of the Imperial Institute, and for some years he provided a large number of subjects for investigation. Results of great importance were obtained, and, in fact, for some years Indian materials were those which chiefly occupied the attention of the department.

Soon afterwards other countries, and especially the tropical Colonies, began to take advantage of the facilities thus provided by the Imperial Institute for the investigation and commercial utilisation of raw materials, and the increasing use made of the department by the manufacturer and merchant at home gradually led to its present extended operations, which have now developed in many directions. The Scientific and Technical Research Department and its recent offshoot, the Technical Information Bureau, are now utilised, not only by the Colonies and India in finding outlets for raw materials, in gaining information as to how these are best prepared and marketed, but are extensively used by manufacturers and merchants in this country for obtaining trustworthy information as to supplies of raw materials or of materials from new sources, and also in gaining information as to their uses and in overcoming technical difficulties in regard to their industrial employment.

I propose now to consider the work which has been accomplished for India, the difficulties which have been encountered, and the lines on which further progress can be made, not only with reference to the extended utilisation of Indian products in British industries, but also to the promotion of industrial enterprise in India itself through the extended industrial utilisation in India of some of the vast resources of that country.

At the basis of the operations of the Scientific and Technical Research Department is the principle that the uses to which raw materials may be put or adapted can best be determined in the first instance by scientific and technical investigation of their composition and properties, by which their industrial use is determined.

The question whether a new material is of value, for example, for tanning leather must depend first on the nature and amount of its constituents, which can be ascertained by chemical analysis. This is the scientific aspect of the question, which must be dealt with in the laboratory, but scientific results are at the beginning and not at the end of the inquiry. If the necessary constituents needed for tanning leather are proved to be present, the actual suitability of the material for tanning leather and its capacity for tanning certain classes of leather have next to be ascertained. This is the technical aspect of the matter which must sooner or later mean consultation with the practical tanner. If the material is proved to be suitable for tanning certain kinds of leather, the commercial question is the next to be determined, the price which will be paid for it. and at this stage the views have to be ascertained of several manufacturers of the particular classes of leather for the production of which the material has proved to be suitable. Assuming that the price provisionally fixed is one which is satisfactory to the manufacturer, the next question is whether this price will be profitable to the exporters in India. Inquiries have, therefore, to be made as to the sources of supply in India, the amount which could be annually exported from India, the export price and the arrangements for export. At this stage reference to India, therefore, becomes necessary, and ultimate success will depend on the means which

exist there for assisting the enterprise. Lastly, assuming that everything is satisfactorily arranged in India, the next step is for a large trial consignment to be exported to test the market at home and to open the new channel of business. This, which may be regarded as the final stage, requires preliminary arrangements on this side with brokers and merchants as well as with manufacturers.

The system is a comprehensive one designed to do all that is needed to initiate the commercial utilisation of a new material, the entire work being controlled by one organisation specially adapted for the purpose. Stress may be laid on the supreme importance, if success is to be attained, of one organisation being responsible for the whole of the operations described, for this secures unity and directness of purpose, avoids waste of effort, overlapping of work and misunderstandings.

Much is heard of the apathy of the British manufacturer, of his want of initiative and enterprise, and his indisposition to recognise the importance of science in relation to his business. The experience of work at the Imperial Institute is that success in initiating new industrial development depends very largely on the manner in which the case is prepared and presented to the manufacturer, and the extent to which the requirements of an industry and the manner in which it is conducted have been ascertained and studied, and especially on the completeness and clearness with which the case is put in relation to the technical developments required.

It is not enough to have obtained in the laboratory a definite result of scientific interest. It is necessary in addition to demonstrate the practical applications with precision, and to indicate the probable commercial results for the industry affected. The power of interesting the manufacturer depends, therefore, not only on knowledge of the scientific result, but in large measure on the ability to discuss this result in connection with the details of the manufacture concerned. For this reason the work of the Imperial Institute has not been restricted to scientific investigations of raw materials, but has included a study of the uses to which they are put throughout the world.

Before proceeding to describe more in detail the machinery of this organisation, it should be mentioned that the possibility that the raw material in question may be industrially employed in India has always been kept in view, but as this question is a separate and complicated one its special consideration is best dealt with later.

I may now proceed to describe the details of the organisation at the Imperial Institute for dealing with the separate stages of the problems which have been referred to.

The Imperial Institute is provided with research laboratories, technical testing plant and machinery for conducting the whole of the work in the scientific or first stage, and for all the preliminary work in the technical or second stage. The staff of the department includes trained workers to whom are allotted separate sections of the materials to be dealt with, which include fibres, oil-seeds, tanning materials, rubber, feeding-stuffs, minerals, etc., etc. On the technical and commercial side there are men qualified to deal with these aspects of the problems to be solved.

In addition to the analysis and investigation, the required arrangements exist for small-scale technical trials to determine provisionally the suitability of a material for a specific purpose before the matter is referred to the manufacturer. Between thirty and forty scientific and technical investigators are thus employed in groups allocated to the chief raw materials. The work is controlled by superintendents whose business it is to supervise these investigations, and communicate with the manufacturers concerned and keep themselves in touch with industrial requirements. In all important industries it has been found that representative firms are ready to consider the employment of any new material as to which precise and accurate information can be supplied as the result of the various researches conducted at the Imperial Institute. To revert for illustration to the case of a tanning material, the composition and properties of which have been investigated in the laboratories, small-scale trials of the material as a tanning agent will also have been made at the Imperial Institute, and various samples of the leather produced will be available. These results are sufficient to induce the manufacturer to give immediate attention to the subject, and to decide whether the material is worth development; in which case he is usually ready to make further large-scale trials with it in the factory.

The Institute has established relations with manufacturers and users of all classes of raw materials, who are ready to assist the Institute to discover new industrial openings for the raw materials of the Empire.

A department charged with the complicated and many-sided problems which have been

referred to requires to have within its organisation, not only a staff of thoroughly competent laboratory investigators, but in addition efficient arrangements for collecting information respecting the existing sources of supply of the raw materials of commerce and the advances which are being made in their utilisation in all countries. For some years this information has been systematically collected at the Imperial Institute and arranged for use. There has been a steadily increasing flow of inquiries from British manufacturers, merchants, and brokers for information of this character.

In addition to the requests for information received from this country, similar requests are received from the Colonies and India, and the Technical Information Bureau has since the outbreak of war found its hands very full of important work.

The operations of the Scientific and Technical Research Department have now been outlined and illustrated. It should be added that samples of the products which have been investigated in the department are added, with full descriptive labels, to the collection of Indian products shown in the Indian Section of the Public Galleries. This collection has served on several occasions to initiate important investigations, and has also been used as a means of verifying the nature of materials used by manufacturers, and has been invaluable as a reference collection of Indian materials, and as affording to the inquirer samples of materials which have been investigated and valued.

The position of a material which has reached the stage of having been proved by investigation at the Imperial Institute to be of commercial value may now be considered.

It is necessary to arrange for supplies, and to interest Indian exporting firms to do all that is needed to develop enterprise in India. It is in this connection that the Institute has so far experienced the greatest difficulty. There is no Government organisation in India whose special business it is to deal with this side of the question, and the utilisation of several materials is thus delayed. The work is outside the scope of a special Department such as that of agriculture or forestry, which is able to assist chiefly in the collection of information as to the principal sources of supply available for export. At present neither the Department of Commerce and Industry nor the Commercial Intelligence Department can undertake this work in its entirety. The Chambers of Commerce, as well as the Directors of Industry who have now been appointed in many places, may, however, be able to render considerable help in the future, since there is a general awakening to the importance of utilising, so far as possible, our own materials for our own industries.

So far as the advancement of the utilisation by British manufacturers of the raw materials of India is concerned, the exceptional value is evident of a central scientific and technical organisation in London with special knowledge of Indian raw materials, and in close and direct communication with the manufacturers, through whom their utilisation will be chiefly secured.

It is natural that every country should desire to do within its own territory the most it can do to develop its own resources, and the question of how much can be done in India is obviously important.

In this connection it should be pointed out that there is still much to be done in interesting British capitalists in industrial development in India, and the work of the Imperial Institute in bringing Indian raw materials to the direct notice of British manufacturers is of great value in this direction.

In the development of agriculture India has made great strides, as Mr. MacKenna has shown in a paper recently read before this Society. On the scientific side the Central Research Institute at Pusa has devoted itself to the investigation of the scientific problems of Indian agriculture, and has rendered great service, notably in the subject of plant-breeding in its relation to the selection of the type of plant best adapted for the production of the economic product required, of which the work on wheat furnishes a striking example. The scientific work conducted at Pusa, involving as it does systematic investigation of agricultural problems, is a necessary part of the scheme for improving and developing Indian agriculture. The Institute at Pusa is, in fact, rendering to Indian agriculture the same kind of service as that which has been for so many years rendered to agriculture in this country by the Rothamsted Experimental Station. On another occasion (Presidential Address, International Congress of Tropical Agriculture, 1914) I ventured to point out that in a vast country like India it would be a mistake to suppose that rapid advances and far-reaching results will be obtained through the operations of only one centre for research in India.

The Provincial Departments of Agriculture require to be as effectively equipped for systematic research as the various local agricultural

colleges and institutes are in this country. The conclusions reached in one province or district of India require to be confirmed, and in many cases amplified by experimental trials, before they can be accepted as true for another province where the agricultural conditions may be very different. In this connection the experimental farms which have been established in many of the provinces of India are of great importance. These farms are essential to the practical adoption of the results of agricultural research, for it must not be forgotten that practical tests of the suggestions of scientific research and actual observations and demonstrations by the trained agriculturist in the field are as essential to the actual progress of agriculture as the observations and tests of the clinical observer are to the advancement of medicine. The real problem for India is how to bring these two directions of progress into effective co-operation. It is not, however, my purpose in this paper to discuss the organisation of agricultural research, except in so far as it is necessary in considering the manner in which the economic resources of India are to be developed.

The Provincial Departments of Agriculture in India are now in direct communication with the Imperial Institute. In determining the relative quality of the actual products of Indian agriculture, in ascertaining their suitability for particular purposes and suggesting new fields for their use, the Imperial Institute, as I shall show, has rendered great service to India; and no unprejudiced observer can doubt that work of this kind, which requires knowledge of European industrial conditions at the moment, of the requirements of the various markets, and which needs discussion with manufacturers and merchants at home, can best be conducted through one central organisation in London which possesses special facilities for the expert examination of materials and for ascertaining the facts at first hand, and this is true whether the materials are to be exported or utilised in India in new Indian industries.

In forestry the Forest Department in India has, especially through the Forest Research Institute at Dehra Dun, an organisation which can render great service in developing the utilisation of the forest products of India. It will, however, be unfortunate if it is assumed that such an organisation in India, however ably equipped, can by itself reach complete commercial or industrial success. Whether the problem is to find an outlet for the export of a forest product or to secure its utilisation in India, it will be essential to consider the results of similar technical and commercial undertakings in Europe, and it is this information which the Imperial Institute is organised to provide.

Research in India is mainly concerned with improvements in the production of existing materials to suit the purposes of the commercial user, as in the cases of wheat and cotton where it is to the interest of India that better descriptions should be grown, or with securing the production of new materials which have been proved to be of value, of which several illustrations are given in this paper. Such work must necessarily be conducted in India.

Research at the Imperial Institute, in communication with Indian Departments, is mainly concerned with ascertaining the value of raw materials for the purposes of British industry and commerce—that is, in investigating and introducing new materials and in finding new uses for materials already known. This work can only be efficiently conducted in this country in close co-operation with manufacturers.

These two lines of work may often be inter-related. Both are of importance, the one in India leading to the production of the material required, the other at home for securing its use.

The operations of the Commerce and Industry Department of the Government of India should in future be in closer touch with the work of the Imperial Institute, and especially through the Commercial Intelligence Department in Calcutta, which has been recently rearranged. In particular, by means of its publication, the *Indian Trade Journal*, much can be done to make known in India the openings for Indian raw materials and the possibilities of industrial enterprise. During the directorship of the late Mr. F. Noel-Paton this department worked with the Imperial Institute on several subjects in which technical information and commercial suggestions were required.

In the future the Commerce and Industry Department might well furnish in India the link which is needed between those in India who are anxious to see the raw materials of India more fully utilised, as far as possible in India itself, and the Imperial Institute, which is equipped and ready to supply information and undertake the special investigation and research at home which is needed.

The Directors of Industries and the Chambers of Commerce in the Provinces should also become powerful agencies for the same purpose,

and during the present crisis their co-operation with the Imperial Institute has proved to be of great value.

Much could be also accomplished in this direction by the publication in the *Indian Trade Journal* of the results of inquiries and researches conducted at the Imperial Institute which are likely to be important to Indian commerce.

The investigations of Indian raw materials in the laboratories of the Scientific and Technical Research Department of the Imperial Institute, and the inquiries now undertaken by the Technical Information Bureau, cover a very large field. There are but few important materials mentioned in Sir George Watt's comprehensive "Handbook to the Commercial Products of India" which are not referred to as having been investigated and their commercial value ascertained by this department of the Imperial Institute. Many of these materials which proved to be of probable commercial value were not sufficiently abundant at the time in India to render commercial development feasible. In some cases, however, these materials have since been produced in quantity, whilst several have been cultivated and are now exported. The main purpose of the joint work of the Reporter on Economic Products and of the Imperial Institute was a comprehensive survey of every class of the raw materials of India, so that their possible uses might be ascertained and put on record. The importance of such an inquiry, conducted, as it has been, at the Imperial Institute with the assistance of British merchants and manufacturers, is very great, and perhaps this importance will be more generally realised at the present time, when it is obvious that every effort must be made to develop and utilise the natural products of India for the benefit of the Empire as a whole, and not least for the benefit of India herself.

There are important and abundant materials which cannot, at present at all events, be utilised in India itself. Many of these have hitherto been exported to Germany and other foreign countries, and the Indian producer has recently experienced the disadvantages of an almost exclusively foreign channel of trade.

Some striking illustrations of Indian dependence on the predominant utilisation by foreign countries of her raw materials have been given in a monograph on "Oil Seeds and Feeding Cakes" (London: John Murray), which was issued by the Imperial Institute last year. Oil seeds of the value of several millions annually have hitherto gone from India to Germany and other foreign countries. Hides and skins for tanning, also to the value of several millions annually, have also gone to foreign countries, and chiefly to Germany. Medicinal plants for the manufacture of drugs are in the same case, and there are many others.

The information accumulated at the Imperial Institute respecting Indian materials, as the result of many years' work, has enabled the Institute to be of very material assistance in relieving these difficulties caused by the war. Through the recently established Technical Information Bureau, it has taken every step to draw the attention of the British manufacturer to the uses of ground nuts, hitherto little known in this country, as a source of edible oil and of a most valuable feeding cake for animals. Thymol, a valuable drug hitherto produced in Germany, has been shown to be easily obtainable from the ajowan seed of India, which had hitherto gone to Germany for the purpose.

In both these instances, as I shall show later, practical results have followed. Ground nuts are being taken by English seed-crushers, and thymol is being made in this country from Indian ajowan seed.

The future of the Indian hide, skin and leather industry is under active consideration, and there seems to be no reason why selected Indian hides should not be used in the United Kingdom to a far greater extent than they have been in recent years, and also converted more largely into leather in India and exported tanned or partly tanned.

It should be possible to make in India large quantities of paper pulp, sufficient not only to provide for the manufacture of paper used in India, a large proportion of which comes from abroad, but in addition to supply the United Kingdom with pulp for paper manufacture. Canada and Newfoundland are at present the chief sources of paper pulp within the Empire, but most of the pulp used for paper manufacture is still imported from foreign countries—notably Norway, Sweden and the United States. In Canada and Newfoundland the cost of labour is an obstacle which in India would not be so great, and for this reason the making of paper pulp, like the tanning of leather, appears to afford good openings for additional Indian industries, since the raw materials are to be found in abundance.

I may now give a brief description of some of the more important commercial products of India which have been investigated from the scientific, technical and commercial standpoints in recent

years at the Imperial Institute, and a number of which have been introduced into commerce.

DRUGS.

Opium.—The opium of India very early received attention. It was shown by detailed investigation of the opium produced in various districts throughout India that whilst some samples are so poor in morphia as to justify the popular belief that Indian opium is inferior to Turkey and Persian opium for medicinal use and for the manufacture of morphia, the opium produced in the majority of the opium districts of India is as a rule sufficiently rich in morphia to render it suitable for both these purposes. Samples of Indian opium were as rich, and some even richer, in morphia than good specimens of Turkey and Persian opium, whilst certain of these samples possessed the advantage of containing more of the valuable alkaloid codeine than is usually contained in other opiums. Trials of selected specimens in medicine arranged by the Imperial Institute at St. Thomas's Hospital showed that the therapeutic results are entirely satisfactory, and trials of Indian opium for the manufacture of morphia and codeia proved to be equally satisfactory. The attention of the Government of India was in consequence drawn on several occasions to the possibility of exporting Indian opium for medicinal use, but before the outbreak of war the Government of India saw considerable difficulties in the way of permitting an export trade. Since the war, however, Turkey opium has become scarce, and there has been an increased demand for the drug. Under these circumstances the export of a certain amount of provision and excise opium has been allowed to this country, where it is being employed chiefly for the manufacture of morphia and codeia.

The matter ought not, however, to rest here. Provision and excise opiums are of comparatively poor quality, being an average mixture of a number of samples reduced to a definite consistence, the result being a relatively poor material. By selecting for export those varieties of opium which have been shown to be the richest in alkaloids a much more valuable material would be furnished. Scientific experiments in breeding a poppy which will under Indian conditions produce opium of good quality have been already commenced, and will no doubt eventually furnish important results. In the meantime, by selecting for growth in the opium districts those varieties of poppy which have been shown by the investigations at the Imperial Institute to yield the best opium, an increasing output from India of opium of better quality could be arranged without delay. A detailed report on Indian opium embodying the results of all the researches conducted at the Imperial Institute during a number of years has now been published, together with suggestions and recommendations, in the *Bulletin of the Imperial Institute* (1915, Vol. XIII. pp. 507-546).

There can be no doubt that India might in the future contribute the whole of the opium required for medicinal purposes in this country, and, if need be, throughout Europe and the United States.

Podophyllum Emodi.—One of the best-known purgatives used in medicine is the root of the American plant *Podophyllum peltatum.* Detailed researches at the Imperial Institute have shown that Indian podophyllum (*P. Emodi*) can be employed for the same purpose. Extensive and wholly satisfactory medical trials having been made, the Indian drug has for some years been in demand. The supply of the wild plant from India until recently has been small, but it has now been put under cultivation, and it is hoped that supplies will be increased. The drug is now included in the British Pharmacopœia.

Aconites.—The investigation of the composition and therapeutic value of the various Indian aconites is, from the scientific point of view, one of the most important investigations which has been conducted for India at the Imperial Institute. As a result of researches which have extended over a number of years, the alkaloids have been isolated and their chemical characters determined, whilst, with the valuable co-operation of Professor J. T. Cash, F.R.S., of the University of Aberdeen, their precise mode of action and therapeutic value have been ascertained. It has been made clear that several of these alkaloids are valuable therapeutic agents. A series of important papers on the pharmacology of Indian aconites has been published in the *Philosophical Transactions and Proceedings of the Royal Society*, whilst a similar series of papers on their chemistry has been published in the *Transactions of the Chemical Society.*

Henbane.—The recent dearth of the alkaloid atropine and its congeners hyoscyamine and hyoscine (scopolamine), and the high prices commanded by these solanaceous alkaloids which are largely used in ophthalmic medicine, are due to their manufacture having been carried on in Germany. Some years ago a solanaceous plant (*Hyoscyamus muticus*), closely allied to

common henbane and growing wild in Egypt. proved on investigation at the Imperial Institute, to be a most valuable source of these alkaloids, and since the outbreak of war the Imperial Institute has arranged for large quantities to be sent from Egypt to this country, where it is now being employed by manufacturers. Before the war Germany had taken nearly the whole supply from Egypt.

The same plant grows in India, but investigations at the Institute have shown that the wild plant from Northern India apparently may contain less alkaloid than that from Egypt. In view of the demand for the drug which is not likely to be met from Egypt alone, the question as regards the Indian plant deserves further investigation.

The same is true of the related plant, *Datura Metel*, which examination at the Imperial Institute has shown to contain the valuable alkaloid scopolamine, though with Indian samples in smaller amount than is usual in the plant grown in other countries.

On the other hand, *Datura Stramonium* from India has furnished quite satisfactory amounts of alkaloid, and if procurable in quantity would be of value.

The question of the production in India of solanaceous plants is one which is worth further consideration. For commercial production the collection of wild plants could not be depended on, and cultivation would have to be undertaken. This should not be difficult, as the plants grow readily in Northern India.

Tanning Materials and Leather.

A large number of investigations have been made at the Imperial Institute of the value of Indian tanning materials, with a view to the export to this country of those which are rich in tannin, but were not known or used by the British tanner, and to the utilisation of those such as the barks of cassias, acacias, shorea, and mangrove, which are too poor to repay export in the crude state. Some of these, however, might be profitably manufactured into extracts in India, and partly utilised there and partly exported for tanning purposes in this country. This work has involved not merely investigation of the constituents of the materials, but technical trials in communication with tanners.

Much of this work has been done in co-operation with the Forest Department and with the Forest Research Institute at Dehra Dun. After many years' work some progress has been made, and the manufacture of extracts from these materials is about to be tried systematically.

There is a great opening for the development of tanning extract manufacture and of the tanning industry in India, including the extension of native tanneries.

The supply of suitable hides and skins is enormous, and a large part of these which have hitherto been exported chiefly to Germany should in future be tanned in India. No doubt, in some instances, chemical or chrome tannage could be adopted with advantage, but vegetable tannage should remain an important Indian industry and receive development on scientific lines. A definite scheme of operations is required, in connection with which the needs of Indian tanners and those of the British purchasers should be taken into account.

Among the unutilised vegetable tanning agents of India which have been investigated at the Imperial Institute is *Caesalpinia digyna*, a common plant in many districts of Assam and Burma. Investigations at the Imperial Institute have shown that the shells or cases of the seed pods of this plant contain about 60 per cent. of tannin. Technical trials as a tanning agent on a small scale showed that the material produced excellent leather, and this conclusion has been confirmed by trials on a large scale in the tan-yard. A demand in consequence arose for the material in this country, but so far the supply has been small, but whenever the pod-cases of *C. digyna* have been offered they have been sold readily at good prices. It would appear that the cost of collecting and shelling pods from the wild plant will interfere with the extended use of this promising material, and that further progress can only be made through the cultivation of the plant in India, which is now under consideration.

Turpentine Oil and Rosin.

The pine forests in the Punjab and the United Provinces have been worked to a certain extent, and several factories for the distillation of turpentine oil and the preparation of rosin have been in operation for some years by the Forest Department. All the turpentine oil and rosin at present produced is used in India, and there is at the moment no question of these products being exported from India to Europe, although it is possible that such an export may be undertaken in the future. Most of the turpentine oil is obtained in India from *Pinus longifolia*, as this species is the most abundant and accessible; but other species, such as

P. excelsa and *P. Khasya*, also occur which might be used.

The oils of these species have been examined at the Imperial Institute as well as the crude turpentine (oleo-resin) of *P. excelsa* and *P. Gerardiana*, and the resin (colophony) of *P. longifolia*, *P. excelsa*, and *P. Gerardiana*.

The oil of *P. longifolia* from India was found to differ from the American and French turpentine oils. There seems little possibility of the oil from the Indian *P. longifolia* being accepted in commerce as similar to the best grades of American and French turpentine oils, and it would have to be sold on its own merits as Indian turpentine oil. The Indian oil, however, is as good as Russian oil, for which there is a large market in the United Kingdom, and in recent years, owing to the rise in price of American turpentine, various methods of utilising inferior turpentines have been devised, so that when Indian turpentine from this species is produced in excess of Indian needs there will be no difficulty in finding a market for it in the United Kingdom.

The oil from *P. Khasya* is rather better than that from *P. longifolia*, and is quite equal to the lower grades of American turpentine.

The oil of *P. excelsa*, on the other hand, when properly prepared, is comparable with the best French turpentine oils of commerce.

Further information is needed as to the yield of turpentine from these Indian pines, but from what has already been done there seems no reason to doubt that the yield is as good as from French and American pines.

The rosin from *P. longifolia*, *P. excelsa*, and *P. Gerardiana* was found at the Imperial Institute to be very similar in composition to that from the United States and France, and could be used for the same purposes; but its manufacture needs to be improved to produce pale-coloured rosin of the best type.

In addition to the chemical investigations of Indian turpentine and rosin, steps were taken to bring them to the notice of manufacturers in the United Kingdom. In this connection an article on "The Production and Uses of Oil of Turpentine," including references to the Indian products, was published in the *Bulletin of the Imperial Institute* in 1906, and other reports dealing more especially with Indian turpentine have been published at intervals since that time.

A large plant of French design has recently been installed in the Government turpentine factory in the Punjab, which should result in turpentine of better quality being produced.

As a result of this action, inquiries have been received at the Imperial Institute from several British manufacturers, and in some cases trial consignments of Indian turpentine oil have been obtained on their behalf. These have proved fairly satisfactory; but in every case the price has been prohibitive, and for this reason alone it has not yet proved possible to import regularly Indian turpentine oil to this country.

The production of turpentine and rosin in India has, however, now been firmly established, a good local demand has been created, and as the industry is profitable the Forest Department is wisely extending it, and it is quite possible that eventually there may be an excess available for export. In any case, the Indian production has been of indirect benefit to British manufacturers, as it has increased the available supplies of turpentine and has made available for European use a large part of the French and American turpentine formerly imported to India. Prices of turpentine oil have been steadily rising for the last few years, and the rise would probably have been considerably more rapid if India had not come forward with additional supplies for her own use.

The Imperial Institute has throughout been in close co-operation with the Forest Department and the Forest Research Institute in India on this question. Up to the present the Government of India has itself worked the pines for turpentine, and the important point still remains to be settled as to whether this policy should be continued, or whether certain areas of pines at least should not be conceded for development by private enterprise.

The Imperial Institute is in communication with at least one important British firm that is willing to take up and work such a turpentine concession in India.

Burma Beans.

The edible beans most commonly grown in Burma are varieties of *Phaseolus lunatus*, large quantities of which are exported to the United Kingdom and the Continent, where they are commonly known as Burma or Rangoon beans. Those shipped are of two kinds, small reddish beans, and white ones resembling "small haricots" in appearance. During the course of an investigation conducted at the Imperial Institute on the production of prussic acid by certain plants, it was found that the Rangoon beans, when ground into meal and mixed with water, gave indications of the presence of this poison. In the case of the red beans, the quantity of prussic

acid formed was not exactly negligible though usually harmless, whilst the white Burma beans as a rule yielded little or none.

So far as is known, no harm has arisen from the use of the beans as a feeding-stuff. The export trade in these beans from Burma continues to flourish, but as the yield of prussic acid is variable, the beans are sometimes regarded with suspicion by agricultural experts in Europe; and for this reason they bring, in ordinary times, comparatively small prices in the market.

In view of these facts the Imperial Institute, in consultation with merchants in London, suggested to the Department of Agriculture in Burma that steps might be taken to encourage the natives to cultivate for export a better class of beans suitable for human food. In order to carry out experiments from this point of view, a special experiment station was established by the Department at Natywagon. The Imperial Institute forwarded samples of the large white butter beans (Madagascar beans) which are in demand in this country to the Department for trial cultivation, and later on two tons of similar beans were forwarded by the Institute for experimental cultivation by co-operative credit societies in Burma. These butter beans belong, like Rangoon beans, to the species *Phaseolus lunatus;* but through cultivation they have lost to a large extent their characteristic of producing prussic acid, and it was hoped they would retain this cultural peculiarity in Burma. It was also suggested by the Imperial Institute that trials might be made with the true white haricot bean, and a supply of one of the best varieties of the white haricot bean was forwarded to Burma for this purpose this year.

Madagascar beans have now been grown in Burma for three seasons, and the produce has been examined at the Imperial Institute. Although the beans were found to yield somewhat more prussic acid than the original beans, the quantity was negligible, and less than that yielded by the ordinary Rangoon beans.

If the Madagascar beans are found to give satisfactory yields in Burma, and to retain their characteristic of large size and minute yield of prussic acid, they would be far more profitable to grow than the Rangoon beans. In the case of one sample of Burma-grown Madagascar beans, a firm of merchants in London stated that consignments of equal quality should realise the ordinary price of Madagascar beans, which is about £20 per ton, against £6 per ton for Burma beans. These are, of course, pre-war prices. Samples subsequently received were smaller than the original beans, but it was stated by a firm of merchants that they would realise good prices. At the present time all edible beans command exceptionally high prices.

[The concluding portion of the paper, with the discussion, will be published next week.]

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Quilts, Indian and English.—The East Indian painted calicoes of Mr. G. P. Baker's valuable paper (*Journal*, May 19th) were assuredly used by our forefathers to make quilts. Other evidence might be tendered than Mr. Baker's citation from Defoe, and notably certain correspondence of the factors of the East India Company. Thus, in 1632, Thomas Woodson, at Masulipatam, informed Thomas Colly, of Surat, that he would be glad of a chintz to make a quilt. Quilts and cotton yarns "bought in Baroach and Cambaiett" were important articles of contemporary Dutch trade, but it is not clear that all the quilts were calico. Silk and satin quilts were part of the traffic of the Company, some of them inferentially of Indian origin, and others from "China, embroidered with gold," and from "Pitania, embroidered with silk." It is apparent that the calico quilts were stuffed with wadding and stitched by the needle, although this was not necessarily so in the case of the remainder. In our own country the making of worsted bed cloths and of woollen bed coverlets ranked among the early occupations of Norwich and York. A bed "of quoiltene and of materasz" is recorded in the thirteenth century, and "beddes of selk echon, Quiltes of gold thar upon" in the fourteenth. Of these, as of the "three flourished quilts for every bed," mentioned in Johnson's "Idler," it can be affirmed with some confidence that they were quilted by the needle.

The Society, in virtue of its eighteenth century awards, has inherited some interest in quilts, East Indian and British, and it may be permissible to quote the "History of the Society," showing that between 1761-65 a sum of £410 was expended in rewards for "Quilting in the loom." There was a prize for "a quantity of quilting, made in a loom in imitation of, and nearest in goodness to, the Marseilles or India quilting." Fine Indian quiltings are mentioned in two feminine diaries of the preceding half century, and it has been demonstrated that quilts had for long been brought from India. A theory can easily be constructed to explain the alternative name of "Marseilles," for the French had interests in India—they were leaders of fashion then as now—and Marseilles was their port for Eastern trade. The Society's premiums served their purpose.

Samples of a gradually improving character were produced in silk, cotton, linen and wool, and in 1765 the Committee on Manufactures reported the manufacture in this country to be sufficiently established.

The manufacture of Marseilles quilts and the weaving of other goods upon a like principle continues to this day. A short description should suffice, and for an example there is no need to go beyond a specimen exhibited before the Society by Mr. Baker, and obtained by him from Asia Minor, but possibly not of Asiatic manufacture. The pattern of diamonds and branchlike tracery is such as might be worked by the needle, and the black threads forming the low relief upon the quilted face simulate sewing-cotton passably well. But the fabric is a compound woven structure consisting of a close plain silk face cloth, with its own buff warp and weft, a spidery back fabric with a buff warp and a black cotton weft, with a bulky weft of buff cotton sandwiched between. There are two warps and three wefts, and the lifting of the back warp has been controlled by the jacquard to form a relatively large pattern by the singling out of threads for interweaving with the face fabric. The third thick weft, consisting in this case of a bundle of twelve cotton threads woven as one, is fully concealed by the face and semi-concealed by the back. The office of the third weft is the passive one of adding weight and warmth, and forming a filling for the pouchy high relief. The cloth could be woven upon any broad enough loom having two shuttle-boxes at each end, two warp beams, and a jacquard or equivalent attachment. Although the Marseilles quilt has been superseded largely by other compound woven structures, it remains a clearly identifiable article of commerce. To round off the relation between the Indian quilt and its British counterpart it may be said, on the evidence of Mr. T. N. Mukharji's "Arts and Manufactures of India," that in India quilts are *soznis* in the vernacular. In Bengal they are worked by the needle, and in Broach upon the loom. It was from "Baroach" that the seventeenth century quilts came, and it is not too improbable a supposition that they were produced by weaving in substantially the manner described. Mr. Mukharji's account of the Bombay method speaks of the weaving of little bags by uniting an upper and a lower fabric in the loom, but he suggests that these are stuffed as the work proceeds with cotton wool. The net difference lies between employing a bulky third weft to form a wadding, and inserting loose material with the fingers; an alternative that could certainly not be without practical inconveniences.

The Government's Wool Purchase.—The wool clip of the United Kingdom, of approximately 120,000,000 lb., equals one-seventh or less of the wools consumed in the manufacturing industries of this country, and about one-twentieth of the annual commercial supply of the world. Even so, its acquisition entire by the Government remains a considerable transaction involving probably £6,000,000. Had the prevailing market price been paid the bill must have been nearly £1,000,000 higher, and in buying the clip at 30 per cent. over the prices of 1914 the authorities may be said to have made a saving of that amount. Had large Government orders been given for cloths, and still more had exportation been freely allowed to neutral markets, the price must have advanced substantially, and conceivably to the amount of an extra million. It is understood that the Government, after allotting material to satisfy its own requirements, will dispose of the balance in open market, when a useful commercial profit may be reasonably anticipated. The scale of prices, which has been arbitrarily fixed, means that the producer should receive twice as much for this year's wool as for that of the low year 1908. Any excess value is diverted from the private to the public pocket, and in defence of this rather severe measure special circumstances can fairly be pleaded. Government contracts account for a large part of the actual and prospective rise in prices, and in protecting themselves against an unlimited rise, the authorities are doing in essence what has been done already in respect of some other indispensable commodities. A reputation they have acquired for the considerate handling of complex problems has gone far to soothe industrial opinion, which, until the general intention had been exposed, was fluttered and uncertain.

Wool Trade Organisation.—The British wool trade is to a considerable extent separate from that in colonial and foreign wools, with an organisation adapted to meet the elastic needs of the case. Between the farmer and the industrial consumer are a number of intermediaries, of whom the auctioneers in the country markets are among the first and most important. There are seedsmen, and, in Ireland, grocers, who take payment in wool, and who thus become sellers of the produce. Agents of various degrees add to their incomes by buying wool at a commission on behalf of distant wool merchants. Then there are the merchants or staplers, resident chiefly in the industrial area, who buy at auction or otherwise, and who sell fleeces, after more or less selection and rejection, to the manufacturer, and who meanwhile provide warehousing and other accommodation. The interests of these various parties are closely touched by the intervention of the State.

Types of British Wool.—To the outsider even the native wools are objects of a certain mystery, but a working knowledge of them is not difficult to attain. The British wools are classifiable into three main sorts: Long, Short, and Half-bred. The first division includes wools of 8–14 inch staple from Lincoln, Leicester, Romney and Roscommon breeds of sheep, useful for hard serges, linings, braids and buntings. Downs sheep provide the

short wools for hosiery and flannels. The half-breds are crosses between the long and short woolled varieties, producing wools of medium length and reflecting the characters of the parentage of the animal. The classification is a highly summary one, covering small differences infinite in number arising from the soil and climate as well as from ancestry. No such uniformity prevails as in the Colonial and South American wools, nor, in view of the size and physical geography of the country, is the production of large bulks of uniform kind practicable. The British wool trade is more complex than some others precisely because it is smaller and is carried on under conditions of less regularity.

GENERAL NOTE.

Arts and Crafts Exhibition.—An exhibition of the Arts and Crafts Exhibition Society will be held next October in the Galleries of the Royal Academy. The exhibition will be open to all craftsmen, whether members of the Society or not, and works will be received and exhibited under conditions similar to those of the summer exhibitions at the Royal Academy. The address of the secretary, Professor E. S. Prior, A.R.A., is 1, Hare Court, Temple, E.C. Based on the successful experiments in Ghent in 1913 and in Paris in 1914, the exhibition will take the form of a constructive demonstration of the creative possibilities of British folk. A series of interiors will be constructed which can be set up and removed without damage. These interiors will be decorated and furnished by different artists, and arranged within them will be individual works selected for their fitness to the scheme of decoration adopted. There will be a large municipal hall, with the side walls divided into bays. Each bay will be decorated by an artist or a group of artists working in harmony with an agreed scheme of decoration. Another gallery will be fitted up as an ideal council chamber. The central octagon of the series of galleries will be fitted up as a series of apsidal chapels, decorated by individual artists or groups of artists. Another gallery will be devoted to university or educational purposes, and will show the decorative possibilities of an ordinary lecture hall or class room. In the entrance gallery or ante-room will be constructed a panoramic suggestion for the reconstruction of Trafalgar Square. Special galleries will be devoted to textiles, metal work, and embroidery. The intention of the Society is to make the exhibition peripatetic—to send it to the principal cities in the kingdom, to the Colonies, the Americas, and perhaps to France and Russia.

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PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

THE WORK OF THE IMPERIAL INSTITUTE FOR INDIA.

By Professor Wyndham Dunstan, C.M.G., M.A., LL.D., F.R.S.,
Director of the Imperial Institute.

(*Continued.*)

Indian Paper-making Materials.

Although India possesses an abundance of fibrous materials suitable for the manufacture of paper pulp, less than one-third of the paper used in the country is made in the Indian mills, and even this is manufactured partly from imported wood-pulp.

The consumption of paper in India in the year ending March 31st, 1914, may be estimated as between 85,000 and 90,000 tons, of which only about 29,000 tons were manufactured in the country itself. The total imports of paper (excluding writing paper, the quantity of which is not recorded) in 1913–14 amounted to 57,607 tons, and of this quantity 13,685 tons were imported from Germany and Austria-Hungary. The imports of writing paper were of total value £259,964, the share of Germany and Austria-Hungary being £63,819.

The imports of wood-pulp and other paper-making materials in 1913–14 were 12,382 tons, of which 4,907 tons were contributed by Germany and Austria-Hungary.

These facts show that an extension of the Indian pulp and paper manufacturing industry might well be undertaken with a view to supplying the whole of the paper required in India. Subsequently it might be possible to create an export trade in paper with China and Japan.

Consideration might also be given to the possibility of establishing an export industry in paper pulp, of which Great Britain and other British countries could take large quantities.

The chief raw materials at present used in the Indian paper-mills are "sabai" grass (*Ischaemum angustifolium*), old rags, jute, gunny bags, hemp, old rope and waste-paper.

Other materials that are available are bamboos, soft Himalayan timbers such as Indian spruce and silver fir, and a large number of grasses. An investigation of many of these materials has been made by Mr. W. Raitt on behalf of the Forest Research Institute at Dehra Dun, and his results have been published in the "Indian Forest Records." I am glad to have had the opportunity recently of affording Mr. Raitt facilities for continuing some of these investigations in the research laboratories of the Imperial Institute.

Fibres.

The fibres of India may be roughly classified in three groups, viz.: (1) textile fibres, such as cotton, flax, silk, jute and jute substitutes; (2) cordage fibres, such as Sunn hemp, Manila hemp and plantain fibre, and Sisal, Mauritius and bowstring hemps; and (3) fibres suitable for other purposes, including upholstery work, the manufacture of explosives and paper-making. Work on Indian fibres of all these groups has been carried out at the Imperial Institute, but in the time at my disposal it is only possible to mention a few typical examples of such investigations.

As an example of the first group, viz., textile fibres, reference may be made to a fibre which appeared on the London market about fifteen or sixteen years ago under the name of Bimlipatam jute, the origin of which was not then known. Analyses, and a comparative examination of commercial Bimlipatam jute with the various Indian Hibiscus fibres contained in the Indian Collections of the Imperial Institute, proved that the fibre was the product of *H. cannabinus*. Consequent on this discovery, considerable attention has been devoted to the plant in India during

recent years, and improved races have been established.

Another fibre of the jute class, *Sida rhombifolia*, on examination at the Imperial Institute, was found to be of such high quality that it was recommended that its cultivation should be encouraged. A good deal of work has now been carried out by the Department of Agriculture in Bengal, and it has been found that the value of the fibre is about 10 to 20 per cent. in advance of "first-marks" Calcutta jute, but that the plant gives a smaller yield per acre and the fibre is more troublesome to prepare than jute owing to the interior of the stem being soft instead of hard and woody. These questions deserve further attention.

The second group, viz., cordage fibres, may be illustrated by reference to the fibre known as Sunn hemp, which is obtained from the stem of *Crotalaria juncea*. Samples of this fibre from Burma, Calcutta, and the Pabna district of Eastern Bengal have been examined at the Imperial Institute. All the samples were of good quality, those from the Pabna district being the best. This product finds a ready sale in the United Kingdom at good prices, and it was pointed out in the report that the cultivation of the crop could be safely extended. The annual exports of Sunn hemp from India during the years 1909–1914 amounted to about 30,000 tons, of which about one-half was consigned to the United Kingdom. Since the outbreak of war the demand for Sunn hemp in this country has greatly increased owing to the difficulty of obtaining Russian hemp, the imports in 1915 being about 28,000 tons as compared with 15,000 tons in 1914.

The third group, viz., miscellaneous fibres, may be illustrated by the products consisting of the seed-hairs of various plants, and known as flosses or silk-cottons. Those of the following Indian plants have been examined at the Imperial Institute and information supplied as to their value and uses:—*Eriodendron anfractuosum* (the true kapok tree), *Cochlospermum gossypium*, *Calotropis gigantea* and *C. procera*. There is an export trade in such materials from India, but it is probable that the source of most of the exported floss is *Bombax malabaricum*.

The use of these flosses has assumed increased importance during recent years. Formerly they were almost exclusively employed as stuffing materials for upholstery, but owing to their buoyancy and impermeability to moisture they are now being used extensively in the manufacture of life-saving jackets and similar appliances. Considerable demand has arisen for flosses for such purposes, and good prices are being realised.

Minerals.

A large number of Indian minerals have been investigated at the Imperial Institute in order to ascertain their suitability and value for various industrial purposes. These include coal, lignite, clays, mica, metallic ores, rare earth minerals, etc., etc. The composition and quality of the various coals of India have formed the subject of several extensive and important reports. In 1902 I gave an account of some of this work in a paper entitled, "The Coal Resources of India," read before the Indian Section of the Society of Arts at a meeting at which Lord George Hamilton, then Secretary of State for India, presided. The predictions I then ventured to make as to the future of the coal supply of India have been amply justified, but some of the difficulties with which a rapidly expanding industry have to contend are, I observe, still encountered. The war has served to emphasise the importance of many industrial positions, and among them the coal supply of India and its capacity to supply the markets of the East. In Egypt, where coal is not known to occur, increasing quantities are being used in connection with the extension of irrigation schemes, and Welsh coal is now obtainable only at prices which would usually be prohibitive. The present transport difficulties stand seriously in the way of Indian enterprise, and the admitted fact that most Indian coal is inferior to Welsh coal constitutes an objection which every engineer will press so long as supplies of Welsh coal can be secured at a reasonable cost. I cannot do more in this paper than briefly refer to this subject, which is full of interest and importance to India.

I must, however, not leave it without referring to the great possibilities which Indian coal offers as a factor of industrial importance to India itself, not only as a source of power, but in connection with the adoption of improved methods of carbonisation and the production of liquid fuel as well as of power gas.

The only other mineral to which I shall be able to refer in any detail in this paper is monazite, of which it is now known that India possesses the richest deposits in the world.

The constituent of this mineral of industrial importance is thorium, which is essential to the gas-mantle industry, an industry which until

lately has been entirely controlled by Germany. Germany, having secured the monopoly of the Brazilian supplies of monazite, was able to dominate the manufacture of gas-mantles in this country. The importance of discovering an additional source of thorium, under British control, was, therefore, very great.

Through the mineral surveys established by it in West Africa and Ceylon, the Imperial Institute was able to attack this problem. Monazite was found in numerous localities in West Africa, but nowhere in sufficient quantity to be of commercial importance. In Ceylon, however, in addition to scattered monazite a new mineral —thorianite—was found, and this proved to be the richest known ore of thorium, containing over 80 per cent. of thoria as against about 5 per cent. in Brazilian monazite.

This is not the occasion to tell the story of the competition of Germany for this new mineral of Ceylon, which was eventually secured by the Imperial Institute for British users by whom virtually the entire output of Ceylon has been taken. Unfortunately, the occurrence of thorianite in Ceylon is sporadic, and the supply is now reduced to small dimensions. The importance of the subject to the British industry was so great that the Imperial Institute drew the attention of the Government of India in 1905 to the German thorium monopoly which placed British manufacturing enterprises at a great disadvantage. It was suggested to the Government of India that a special search should be made in India for thorium minerals, since the existence of these minerals in Ceylon rendered it probable that they would also be found in India. The reply of the Government of India was that no special search was necessary as the Geological Survey were already alive to the importance of the subject, and there the matter rested until 1909, when a German prospector, Schomburg, discovered deposits of monazite sand on the coast of Travancore. Specimens secured by the Imperial Institute were examined, and it was found that the sand was rich in monazite, whilst the monazite contained nearly twice as much thoria as the monazite of Brazil. A company, the Travancore Minerals Company, was subsequently formed under German control, and Travancore monazite was worked in German interests. Since the war this company has been reconstructed, with Sir John Hewett as chairman, and it may, therefore, be hoped that its valuable produce will be secured for British industry. In addition to the area dealt with by this company, it is stated that other areas of the Travancore sands are to be worked by a second British company, so that in future it is to be expected that the gas-mantle industry in this country will be able to pursue a course of untrammelled development.

From this brief account of the mineral work of the Imperial Institute it is clear that it should be a valuable auxiliary to the operations of the Geological Survey of India.

It will be seen that the work of the Imperial Institute has been to an increasing extent industrial and commercial in its aims, and that its scientific and technical investigations have been necessarily directed to this chief purpose. Each report made to India consists for the most part of the co-ordinated results of the work of a number of individuals who have been concerned with different aspects of the problems presented, the ultimate purpose of the report being commercial and industrial and not scientific.

Although the complete investigation from the scientific standpoint alone of any large number of the subjects has not been possible for want of funds, individual workers have been encouraged so far as possible to prosecute research in this direction, the results of which have been communicated by them to scientific societies and published as papers by these individuals. Owing to the limitations imposed on work of this description by the smallness of the funds placed at the disposal of the Imperial Institute, arrangements have been made whereby external workers in special subjects have taken up researches at the suggestion of the Imperial Institute, and by this means a considerable body of scientific work has been accomplished for India, quite apart from the co-ordinated commercial work which forms the subject of the majority of the reports made to India, and which occupies the first place in the scheme of operations. In recent years more than fifty papers on Indian subjects have been communicated to scientific societies.

Work of the Technical Information Bureau.

So far I have briefly described some of the investigations conducted for India in the Scientific and Technical Research Department, and I may now refer to some of the operations of the recently established Technical Information Bureau, which has become of so much importance since the war. In the last

two years several hundred inquiries on subjects of importance to India have been dealt with by the Bureau, whilst the attention of users of raw materials in this country has been drawn by special circulars and notices in the Press to the suitability of Indian materials for certain purposes. Assistance has also been given to the India Office in selecting special officers for technical employment in India, and in several other directions.

It will be evident that there is great room for India in the future to contribute the raw materials, not merely for industries of its own, but for those of the United Kingdom and other countries of the Empire in preference to those of foreign countries. To take only three great groups of raw materials, cotton, copra and hides, the exports from India in 1913 and 1915 are shown in the following table:—

Exports from India, 1913 and 1915.

	Value of Total Exports. £	Percentage to Germany and Austria-Hungary.	Percentage to United Kingdom.	Percentage to other Countries.	
	Raw Cotton.				
1913	24,995,750	18·8	3·3	77·9	Chiefly to Japan.
1915	14,875,818	—	8·4	91·6	
	Copra.				
1913	979,335	77·5	3·8	18·7	Chiefly to Belgium & Russia.
1915	519,056	—	50·5	49·5	Almost entirely to France.
	Raw Hides.				
1913	5,329,656	56·5	3·8	39·7	Chiefly to Italy and the United States.
1915	3,959,117	—	14·3	85·7	

This table shows that in each case there has been a remarkable increase in the percentage exported to the United Kingdom. This, however, is not due solely to an increase in the exports to this country, but is partly the result of a decrease in the total exports. The actual increase in the exports to the United Kingdom in the case of copra and raw hides is shown in the tables on pages 611 and 612.

In the case of cotton nearly the whole has gone to foreign countries, and chiefly to Japan. The reason is that most of the cotton grown in India is coarse and of short staple. This is of little value to the British manufacturer, but is valuable in Japan. It is now known that cotton of the kind required by the British manufacturer can be largely grown in India, and steps are being taken to encourage and extend the cultivation of this kind of cotton. When it is remembered how greatly the British manufacturer is dependent on the United States for the cotton he requires, and how this source of supply has more than once been threatened since the war began, it may be hoped that these efforts in India may be redoubled, and concerted action taken to secure that the cotton grown in India shall be for the benefit of the British manufacturer no less than for that of the Indian producer.

Copra.

In the case of copra, more than three-fifths went to Germany and Austria before the war and a negligible quantity to this country. The figures are shown in detail on page 611.

On the outbreak of war, considerable difficulty was experienced in disposing of the supplies of Indian copra, as new markets had to be found for the product. There was, however, no reason why much larger quantities of Indian copra should not be utilised in the United Kingdom, which previously had imported large supplies of coconut oil from Germany, and soon after the beginning of hostilities the Imperial Institute issued a circular to oil-seed crushers and other firms likely to be interested calling attention to the position, and suggesting that the pressing of copra in this country should be considerably extended. Further information on the subject, including particulars as to the value of coconut cake as a feeding stuff for animals, was published in the *Bulletin of the Imperial Institute*, and also in the Imperial Institute monograph on "Oil Seeds and Feeding Cakes" (1915: John Murray).

As a result of this action arrangements have been made by several British firms to extend their plant for crushing copra, and large quantities are now being utilised in the United Kingdom. It is satisfactory to find that in 1915 the exports of copra from India to the United Kingdom amounted to 211,279 cwt., or about half the total, compared with 35,450 cwt. in 1914, and 29,843 cwt. in 1913. The other half is being taken by our ally, France.

Ground Nuts.

The facts are similar in the case of ground nuts, the great commercial value of which the Imperial Institute has done much to bring to

EXPORTS OF COPRA FROM INDIA.

To	1913.		1915.	
	Cwt.	£	Cwt.	£
United Kingdom	29,843	37,636	211,279	262,198
Russia	44,844	58,049	—	—
Germany	565,743	758,938	—	—
Holland	7,750	9,392	—	—
Belgium	49,691	65,212	—	—
France	23,371	30,405	219,862	252,783
Other countries	15,614	19,703	3,684	4,125
Total	736,856	979,335	434,825	519,056

notice in this country since the outbreak of war. The figures are given in the following table:—

EXPORTS OF GROUND NUTS FROM INDIA.

To	1913.		1915.	
	Cwt.	£	Cwt.	£
Germany	144,427	87,157	—	—
Austria-Hungary	273,260	144,080	—	—
France	3,947,772	2,198,895	2,267,074	989,002
Belgium	370,694	222,103	—	—
Hong Kong	213,012	99,765	1,123	534
Other countries *	152,162	140,242	323,754	131,289
Total	5,101,327	2,892,242	2,591,951	1,120,825

* Including United Kingdom.

The principal market for Indian ground nuts was France, 4,405,798 cwt. out of a total export of 5,237,006 cwt. being sent to that country in 1914; in 1915, however, owing to the disorganisation of the French trade produced by the war, only 2,267,074 cwt. of ground nuts were exported from India to France, and the total exports from India fell to 2,591,951 cwt. Ground nuts had not been previously crushed to any extent in the United Kingdom, and the Imperial Institute, therefore, took similar action with reference to this product as had been taken with regard to copra. A circular on "New Markets for British Indian and Colonial Ground Nuts and their Products," calling attention to the supplies available and to the value of the nuts for edible purposes and as a source of oil and feeding cake, was issued early in 1915 and was widely distributed to oil-seed crushers, merchants and others in the United Kingdom, and a full account of the ground-nut industry was given in "Oil Seeds and Feeding Cakes" (1915: John Murray). As the result of the publication of this information considerable interest was aroused in the subject, and several British firms are now regularly crushing ground nuts, and the imports to the United Kingdom, especially from West Africa, have very considerably increased, although France is still the chief purchaser.

The present activity in the oil-crushing and allied industries in this country leads to the belief that greatly increased quantities of Indian oil seeds will in future be taken by British firms—that is, if these firms can be assured that foreign

countries will not be able after the war to secure a controlling position in the industries and to obtain the command of raw materials which can be utilised in this country.

Raw Hides.

The case of raw hides is even more remarkable, since Germany and Austria were able to secure over half the total output from India, of the value of about three millions sterling. The figures are given in the following table:—

Exports of Raw Hides from India.

To	1913.		1915.	
	Cwt.	£.	Cwt.	£.
United Kingdom	52,507	201,893	135,777	567,700
Germany	408,737	2,015,542	—	—
Austria-Hungary	211,213	998,477	—	—
Holland	51,673	226,758	—	—
Belgium	21,192	93,186	—	—
France	25,638	98,195	20,872	63,569
Spain	55,919	327,332	48,741	265,892
Italy	107,494	541,161	322,883	1,806,916
Turkey, Asiatic	25,588	61,270	—	—
United States	147,957	669,746	239,450	1,019,033
Other countries	24,430	96,096	51,511	236,007
Total	1,132,348	5,329,656	819,234	3,959,117

These hides are now recognised to be of value to the British tanner, and since the outbreak of war they have been extensively employed for the manufacture of boots for our soldiers and those of our Allies. Whilst the exports to this country have more than doubled, large quantities have gone to Italy—quantities far in excess of those which Italy is believed to be in a position to tan. The entire question, which is obviously a most important one, is under consideration at the Imperial Institute. The problem is not merely to secure the use of these hides in this country at the present time, but to assure British traders that their business can be safely continued after the war. An extension of the tanning industry in India would do much to assist a satisfactory solution of this question.

The cases so far discussed are all large well-established Indian industries, and I may now turn to several cases of minor or new industries in which the Technical Information Bureau has given assistance.

Chank and Mussel Shells.

The Imperial Institute was recently consulted by the Honorary Director of Fisheries in Madras regarding a machine suitable for cutting sections from chank shells for the manufacture of the shell bangles which are extensively worn by the natives of India. At present the sections of the chank shells are all cut by hand, chiefly at Dacca, a heavy crescent-shaped saw being used for the purpose, and each cut through the shell takes about five minutes to effect. Attempts to find in Europe some form of machine-saw which would facilitate this operation had failed, and the question was therefore referred to the Imperial Institute.

As the result of practical trials carried out by a firm in this country, at the request of the Imperial Institute, it was found that a type of machine-saw used for cutting Trocas shells would serve admirably for cutting the sections from the chank shells. The saw in question is a circular power-driven saw running under water at a very high speed, and each cut through the shell required only a few seconds to make. Samples of the sections cut by this saw were forwarded to India and were pronounced to be quite satisfactory, and at the request of the

Director of Fisheries one of the saws has been dispatched to India for trial. The use of these machine-saws in India will effect a very great improvement in the manufacture of the shell bangles.

Further assistance has been rendered by the Imperial Institute to the Director of Fisheries in Madras in connection with the possible utilisation of the shells of fresh-water mussels for button-making. It was stated by the Director of Fisheries that fresh-water and other mussels occur abundantly in the Madras Presidency, and that in addition the culture of mussels was being undertaken in the fish farm recently established by the Department. Information was consequently desired as to the types of mussel shells already used for button-making in Europe and the United States.

In response to this request the Imperial Institute obtained and forwarded to India a complete set of the mussel shells which are used for industrial purposes, and also furnished information regarding the various species of shell and the machinery used in the pearl-button industry.

Reports on the value of fresh-water mussel shells which occur in India were also made. The results of the inquiries indicate that a market can be found in Europe for certain kinds of Indian mussel shells. At present these shells are utilised to some extent in India for making buttons and ornaments.

Indian Beeswax.

There is a very large demand for beeswax in Russia for the manufacture of church candles, and after the outbreak of the war the authorities of the Russian Church withdrew the prohibition of East Indian beeswax for the purpose. It was essential, however, that all wax supplied to the Russian Church should be free from adulteration, and considerable difficulty was experienced in obtaining commercial samples of Indian beeswax which fulfilled this condition. Out of forty samples of Indian beeswax examined on behalf of the Russian authorities, only four were pure, the remainder being more or less adulterated, chiefly with paraffin wax.

The Imperial Institute accordingly called the attention of the Government of India to the matter, and also consulted importers in this country with a view to preventing the extensive adulteration of beeswax which is at present practised in India. As a result of this action considerable publicity has been given to the question in India, and steps are now being taken to ensure that supplies of the pure wax will be forthcoming in the future. If consignments of pure Indian wax can be offered regularly on the London market it is probable that India will be able to secure a part of the Russian trade in beeswax, which was valued in 1913 at over £600,000, of which the amount contributed by Germany was valued at no less than £560,000.

The following are the figures:—

From	Cwt.	£
Austria	265	2,057
Great Britain	2,833	22,009
Germany	72,089	560,007
Holland	1,574	12,227
Denmark	710	7,263
Spain	49	385
Other countries	6,129	43,776
Total	83,649	647,724

The exports of beeswax from India are not recorded separately, but in 1913–14 the exports of wax of all kinds, no doubt almost entirely beeswax, were only 8,881 cwt., of which 2,604 cwt. went to Great Britain and 3,849 cwt. to Germany.

Thymol.

Thymol, a solid substance derived from the volatile oils of certain plants, including thyme, has been extensively used as an antiseptic during recent years and manufactured almost exclusively in Germany. The best commercial source of thymol is the volatile oil of ajowan seed (*Carum copticum*), a kind of caraway, which is abundant in India. Before the war almost the whole of the exports of ajowan seed from India went to Germany for the manufacture of thymol. As a result of the war there was at once a serious shortage of thymol in this country, and the price rapidly rose to eight times its usual level. There was, however, no reason why the manufacture of thymol should not be undertaken in the United Kingdom from the Indian ajowan seed. The Imperial Institute accordingly drew the attention of British manufacturers to the subject, and offered to put them in touch with Indian exporters of the seed, which was virtually unknown to manufacturers. In response to this offer a large number of inquiries were received at the Imperial Institute from firms in this country, some of whom obtained consignments

of ajowan seed from India for the purpose of starting the manufacture of thymol, which is now definitely established.

In addition to putting British manufacturers in touch with sources of supply of ajowan seed, the Imperial Institute also rendered assistance to them in connection with the process of manufacturing thymol from the seed. A general process for the preparation of crystalline thymol from ajowan seed was drawn up by the Imperial Institute, and was successfully adopted by manufacturers in this country. In some cases, however, difficulty was experienced in obtaining the thymol in the large transparent crystals formerly produced by the German manufacturers, and the Imperial Institute accordingly made a special investigation of this point. Methods of converting the opaque crystals of thymol into transparent crystals were successfully worked out in the Scientific and Technical Research Department and afterwards communicated to manufacturers. As a result of this action of the Imperial Institute thymol is now being made by several firms in this country, and the product is quite equal in quality and appearance to that previously imported from Germany.

Potash.

Recently the Imperial Institute has had under consideration the steps which should be taken to ensure in the future an adequate supply from British sources of potash, which is of immense value in more than one industry, and especially to agriculture. So far the valuable deposits of Stassfurt, in Prussia, have been the chief source of the world's supply.

In response to numerous requests for detailed information, the Technical Information Bureau published a pamphlet entitled "The World's Supply of Potash," in which the possible sources of supply are considered, including those of India. Of possible Indian sources the deposits in the Punjab Salt Range are the most promising, and the Imperial Institute is informed that the Government of India is taking steps to investigate further their value with a view to their commercial development.

The Imperial Institute is about to enter upon the third stage of its existence, which it may be hoped will see further development of its usefulness to India. The Institute is placed by the Imperial Institute (Management) Act of this year under the control of the Secretary of State for the Colonies, as representing the central authority for the Dominions, Colonies and Protectorates of the Empire. The actual management of the Institute will be with an executive council of twenty-five members, which, subject to the general control of the Secretary of State for the Colonies, will possess considerable autonomy and will be the governing body of the Institute. India is to be represented on this council by four members, one nominated by the Government of India, two by the Secretary of State for India, and one by the Secretary of State for the Colonies. In addition, it is understood that there will be a special Indian Committee of the Council with co-opted members—an arrangement which will greatly increase the connection of the Institute with Indian interests, and, it is hoped, will promote the development of those activities of the Institute for India which are most needed in this country. Contributory to the same end will be the several committees on technical subjects, some of which are already at work, whilst others are in process of formation. It is the earnest desire of all those associated with the operations of the Imperial Institute that it should become, even more than it has been, a centre of intelligence and research in this country for all the raw materials of the Indian Empire.

DISCUSSION.

The Chairman (Lord Islington), in opening the discussion, said he was sure he was expressing the sentiments of all present in saying they were exceedingly grateful to the author for the extremely comprehensive manner in which he had dealt with the various details of the commercial relations which existed between India and the home country. The first point that struck one as a result of the war was that practically every raw product necessary for manufacture and use in this country or elsewhere could be found in one or other of the vast possessions within the British Empire. The second point which had been discovered, and which was being appreciated more and more every day in the public departments, was that some of those raw products, many of which were exclusively grown within the Empire, were in large measure manufactured in foreign countries, and that this country had been dependent in the past for those manufactures upon countries outside the Empire, particularly Germany. Under the demands of the war that had caused great inconvenience in some instances, because it had been impossible to provide plant at short notice to manufacture those articles, some of which were of prime necessity in the conduct of the war. The question was, how was this state of things to be avoided in the future? In the first place, he thought it was clear that every encouragement and assistance should be given to enable

more active enterprise to be displayed by manufacturers throughout the Empire. By that means it would be possible to ensure in years to come that, to a far greater extent, our rich and abundant natural resources were employed within the Empire and not abroad. How was that to be done? One way that had presented itself to many people in the past, and had caused acute controversy, was whether there should be any modification, and if so to what extent, in the existing fiscal system of the country and its relations within the Empire. Committees appointed by the Board of Trade were now sitting dealing in detail with all the staple commodities in their relation to the Empire, and a Commission had recently been appointed with a view to establishing on broader lines the industries in India. He sincerely hoped that, as a result of that inquiry in India, recommendations would be made which would put on a firm and much wider basis a greater number of industries within that country for the manufacture of its raw material. The experiences and revelations of the last two years had placed the minds of all thinking people on a somewhat different platform of thought from that on which they were before. He desired to say without hesitation that he would look at the matter with a clear and open mind, without any undue pre-war convictions, but with the sole view that, in the future, the Empire should build up for itself, within reason and without undue disability, a strong commercial Imperial system. With regard to the work of the Imperial Institute, he was sure all present were agreed as to the overwhelming necessity of employing in manufacture at every stage at the present day the best possible scientific means, and the author had shown that the Imperial Institute had contributed no mean amount towards helping on scientific processes in manufacture. The growing importance of a centre for science and for commercial information, such as the Imperial Institute was in its relation to overseas producers and the home manufacturers, had been emphasised in the paper. It was frequently said that research was best conducted in the country of origin of the production, that countries possessing fine laboratory systems and well-equipped research institutes did not require any other centre than their own; and it was thought by some that that might be the case in India. He had had the opportunity of visiting India, and he was glad to see the splendid strides she had made in that connection in recent years. Anyone who had visited Pusa and Dehra Dun must be deeply impressed with the very valuable work that was being done there. Fine research work was not only being done in the main centres, but also in the provincial institutions. There was room for both provincial and Imperial institutes in India, and they should both be brought up to the very highest pitch of efficiency in regard to their research work; in fact, in the majority of cases the local institute could better experimentalise and deal with its own products than a central institute. He wished, however, to emphasize the point made by the author that whether a country be well equipped with research institutes or not — and India was well equipped—there was not only room but necessity for an institution on the lines of the Imperial Institute in this country. That Institute did not in any way overlap or supplant the institutes in the country of origin, but it was, he thought, a natural and necessary corollary. It had been found that products which had gone through the most careful experimental work in their own country, and had been brought to the highest pitch of excellence as a result of that work, had not always reached the exact stage when they could with the best efficiency be adapted by the manufacturers in this country. It had been found, in many instances, that products from India might have to go through some further investigation in this country, in close individual contact with the manufacturer, in order to present those articles as the best foundation for the manufactured article. That was where the Imperial Institute came in as a final centre for adjusting scientific application to manufacture, and also as a centre of easy and constant communication between the manufacturer who desired the article and the producer in the distant colony. That was the kind of work performed by the Research Department and the Technical Information Bureau of the Imperial Institute, and he believed there was a great future in front of the Institute in that connection, not merely for India, but for other parts of the Empire. He was sanguine enough to believe that, as each country came to realise the immense importance attached to work connected with such an Institute, it would come forward and render every possible assistance. As the author had stated, the Institute was now about to enter upon a new stage of its life. Under a recent Act of Parliament a new executive council had been appointed, or was in process of being appointed, and would soon get to work. The future of the Institute would largely depend on the earnestness and the enthusiasm of those who administered it; it would also largely depend upon the efficiency of its scientific staff, and last but not least upon the financial assistance that it received, not only from the Home Government, but from the Governments of the respective countries within the Empire. He hoped the work of the Institute in the future would be recognised as being of such importance that financial aid would be forthcoming from all parts of the Empire, because he was confident that, with a strong administration and the necessary financial aid, the Institute would constitute in years to come one of the recognised centres of Imperial commerce.

MR. C. C. MCLEOD said the greater part of India was connected with agriculture, but the natives had been allowed to go on cultivating the land in the old-fashioned way, without sufficient practical

nstruction being given them for the purpose of improving the tilling of the land and the utilisation of fresh seed. The last number of the *National Review* contained a striking article dealing with German agriculture, in which it was proved that agriculture in that country had been brought to a very high pitch of perfection. If the scientific application that had been devoted to agriculture in Germany were applied in India, the result would be beyond comprehension. The Commission that had been appointed to inquire into Indian questions would, he was sure, obtain a great deal of important information which would be not only useful to India itself, but to those connected with the Imperial Institute in organising further research towards the perfecting of those materials which came from India. In the ten years previous to the war the trade of India had doubled itself—in fact, it was so important that the Director of Government Statistics declared it showed that India was, in regard to trade, a land of undefined dimensions. No one could define the enormous resources of India. It was of the utmost importance that in the future the people of this country and not the Germans should use the resources of the Empire to the utmost. India was able to produce all that this country required if its resources were thoroughly and scientifically investigated.

COLONEL C. E. YATE, C.S.I., C.M.G., M.P., thought the illustration the author had given them of the attitude of the Government of India in 1905 in regard to thorium brought it home to everybody that the Government of India had been just as callous to the manufacturing interests of the country as the Government at home had been. It had been shown that they had done nothing for four years, and then had allowed the Germans to step in and obtain control. It was to be hoped that one of the great results of the war would be that both Governments would in future pay much more attention to the suggestions given them by people such as the author than they had hitherto done. The Imperial Institute, which for the last thirteen years had been carried on under the author's directorship, under the control of the Board of Trade, had now been transferred, in accordance with the new Act of Parliament, to the control of the Colonial Office, with a permanent committee of twenty-five members. When the Bill was first introduced in the House of Commons, he found that the Government of India was to be represented by two members on the committee, nominated by the Secretary of State, and only one member to be nominated by the Government of India itself. It was eventually resolved that four representatives of India should be elected—two by the Secretary of State, one by the Government of India, and one by the Secretary of State for the Colonies—and he hoped that as a result of that decision Lord Islington would, in the near future, represent India on the committee, where, as all would realise from the address he had just given them, he would be a valuable asset to that country. When the Bill was being discussed in the House of Commons he pointed out that, under the scheme, the Governments of India, Canada, Australia, New Zealand, South Africa and Newfoundland were each given one representative, although the total population of the five Dominions, other than India, was only 20,000,000 compared with 315,000,000 in India. It was hardly fair that Newfoundland, with a population of a quarter of a million, should be put on a par with India, with its 315,000,000. He argued that three of the Indian Presidencies and three of the great Provinces, with an average population of 35,000,000 each, should each have a representative. India was a great continent, not a country; and the Presidencies of Bengal, Madras, and Bombay, and Behar and Orissa, the Punjab, and the United Provinces were just as much entitled to their separate representatives as Australia and New Zealand. But he was a voice crying in the wilderness, and he did not succeed in getting more representatives for India appointed. He was glad to hear from the author that a special Indian committee of the Council with co-opted members was to be appointed. That would give an opportunity of electing some Indian representatives on the committee—a most desirable proceeding, which he had urged in the House of Commons. He trusted that the Indian industries would be well represented on that committee.

COLONEL T. H. HENDLEY, C.I.E., said that, as one of the few survivors of the first Executive Council of the Imperial Institute and the honorary secretary of its first exhibition, he congratulated the author upon his able paper. The departments of technical research and the scientific branches amply fulfilled the ideals that Council had in view. Some of their ideals had not been realised, such, for instance, as the greater popularisation of the Institute and the drawing together of their fellow subjects from the Colonies. He hoped the new departure which had been inaugurated would effect those objects. He had visited the principal trade exhibitions recently held in London, and was convinced that the manufacturers of this country did not realise what an enormous field was open for trade in India, which had been largely exploited in the past by the Germans, who first of all manufactured small articles that were required, with the result that they subsequently introduced larger articles on the Indian market, and thus acquired most of the business. He advised manufacturers to make more use of the Imperial Institute, because they would greatly profit thereby. He also hoped that the part of the Institute which had been surrendered to the University of London would be speedily restored to the Institute. It was most annoying to find the main entrance of the building practically reserved for the use of that body. He would be glad, too, if the original proposal to open a communication between the

Institute Indian galleries and the Indian Section of the Victoria and Albert Museum could be carried out, and a working arrangement made by which the collections in both places could be made to supplement each other.

MR. WILLIAM COLDSTREAM, who had represented the Punjab on the governing body of the Imperial Institute and been for many years a member of its Indian Committee, had watched the growth of Professor Dunstan's work almost from the beginning, and as he listened to the story of the importance and variety of its activities in recent years, experienced the feeling that the Institute had somehow come to its own. He thought there were three outstanding demands connected with the work of the Imperial Institute which it was necessary should be met. First of all, there should be some organisation in India for stimulating nascent industries connected with newly discovered products. Secondly, there should be strengthened the link (found in the Institute) between the producer in India and the manufacturer in this country. Thirdly, there should be (as there is in the Institute) a central co-ordinating organisation which dealt, not only with the products of India, but with those of all other parts of the Empire and of the world. A great many of the products to which Professor Dunstan devoted his attention were produced in other parts, and a central institute alone was in a position to estimate the respective values of the articles as supplied by different countries. Apart from the economic and commercial functions of the Institute, to which their attention had been directed that afternoon, the Imperial Institute, existing as it did as a permanent memorial of the beneficent and empire-welding rule of Queen Victoria, must, if it was to fulfil the aspirations of its founders, be worthy of that great object in its Imperial aims, operations, outward aspect, and public presentation. It should be largely representative of India, because more than a quarter of the cost of its erection was subscribed by India. As regards the magnificent building, he suggested that statues commemorating great men connected with India, both Indians and Europeans, should from time to time be erected on the pediments and in the spacious forecourts—a scheme which he had long advocated; and that the large entablatures which ran along the front of the Institute should be covered with legends and historical memoranda in the various scripts of the Empire.

SIR FREDERICK A. ROBERTSON, LL.D., in proposing a vote of thanks to Professor Dunstan, said he was one of those who suffered in the early days in India through being the head of an Agricultural Department. In those days the Government was not in the enlightened condition in which it was now, and was very much averse to any attempt at self-assertion on the part of departments of that kind. He remembered hearing one very eminent official remark, in connection with the establishment of the new Meteorological Department, that he utterly failed to see the advantage of any such department until it could be shown that it could manufacture clouds and rain. That was the official attitude towards scientific research forty years ago. At that time the Government of India had no particular love for scientific investigation. A very great change, which everyone welcomed greatly, had now taken place, India having, under the influence of one particular Viceroy, made a tremendous move in the direction of scientific investigation and study and its application to practical purposes. The equipment for study and investigation in India was now good, but it was not yet anything like as effective as in a western country which had been at work for hundreds of years; and for some time to come it must be recognised that much work in the way of investigation which could not be done in the country of origin must be done at the Imperial Institute. He congratulated the Imperial Institute on having secured a director remarkable alike for the power of taking broad views and of giving them practical effect.

SIR MANCHERJEE M. BHOWNAGREE, K.C.I.E., in seconding the motion, said he was not quite sure that the work to which the Imperial Institute was now restricted and the space it occupied bore any semblance to its original conception. A large part of the building had been given away for an entirely different purpose to that for which it was originally intended, and the large Imperial conceptions as to its activities had in manifold ways been modified. Until the whole edifice was reclaimed, the full development of its purpose could not be realised. The Institute had, however, under its reduced circumstances performed the best work that could be expected from it. The breadth of view the author had shown in controlling that work was the real cause of the prominent success that had been achieved by him. He did not know why the Institute had been placed under the control of the Colonial Office. If it was necessary to put it under some new administration, he thought joint control by the India Office and the Colonial Office would have been the proper thing. India had also received a very feeble and slender representation on the new body considering the large contribution it had made to the erection of the building, the interest which the chiefs and the people had taken in it from the very first, and the nature of the work which had been originally intended to be performed in the Institute for India. The paper was entitled "The Work of the Imperial Institute for India." The sort of work the author had described no doubt incidentally contributed in some small degree to the benefit and interest of India, but when its chief aim has been to investigate and analyse raw material taken to a country 6,000 miles away to bring it within the

knowledge of the manufacturers of that country, he demurred to the claim that that work was performed for the benefit of the country of origin. There was, however, some satisfaction in the thought that the advantage heretofore taken by other countries of the natural products of India might be derived by England through such operations as had been described by Professor Dunstan. It had required the present war to bring the knowledge of that possibility to the minds of the people of this country, and he was glad that at last some steps were being taken in the required direction. The connection between England and India was intimate, and it was as well to transfer Indian raw materials, from which Germany had hitherto derived so much advantage, to the manufacturers of Great Britain. But he deplored the fact that India herself should be unable to manipulate them and secure the benefit to which she was primarily entitled. The work of the Institute gave no help in that direction.

ARTS AND CRAFTS.

Exhibitions of Arts and Crafts.—Some months ago Mr. Clausen, speaking at a meeting held at the Mansion House, indicated that the Academy contemplated giving its benediction to an exhibition of Arts and Crafts. The announcement, therefore, that such an exhibition will be held at Burlington House in October does not come altogether as a surprise. All those interested in the Arts and Crafts movement will rejoice that at length craftsmen, designers, and the various types of workers in the arts not fine will have an opportunity of showing what they can do in the galleries which, in the eyes of the British public as a whole, undoubtedly hold the first rank. The time, too, is propitious. If many people have no leisure to spend on exhibitions, there are hundreds and thousands who are, from a practical point of view, asking themselves what will happen after the war. They are only too anxious to see how art and manufacture can act in concert and work towards that improvement in the artistic quality of British-made goods, which, more than almost anything else, will help towards the establishment and retention of our supremacy in a number of industries. In some ways, however, the outlook is less promising. The exhibition is apparently not to be managed by a committee of artists and craftsmen drawn from the most important societies connected with the artistic crafts. According to the shorter announcement appearing in the daily papers, it is to be simply an exhibition of the Arts and Crafts Exhibition Society held in the galleries of the Royal Academy. The notice which appeared in the *Journal* last week, comparing the forthcoming exhibition with those held at Ghent and Paris in 1913 and 1914 does, however, suggest a somewhat broader basis. The collections shown in those cities were, from the point of view of craftsmanship—of Arts and Crafts in the more limited sense—admirable, although they had very little to do with the larger industries of the country, with art as applied to our great exports and manufactures. The remark that the October exhibition will be open to all craftsmen—whether members of the society or not—hardly suggests that these important interests will be very seriously considered. There was a time when the appeal of the society would have been wider. Some of its earliest and most useful members were manufacturers. But, as one reads the notice to-day, one is tempted to wonder whether the show at Burlington House will bear much relation to the industrial life of the country at large. At the present time there is great need for all the forces which make for the betterment of applied art to unite. Unfortunately, nowadays, the Arts and Crafts Exhibition Society only represents a comparatively small portion of them. It is to be hoped that on the occasion of the first exhibition of Arts and Crafts to be held at the Academy, the hanging committee, as was the case at Paris at least, instead of being recruited entirely from the ranks of the society, will be more thoroughly representative, and that the competent artists connected with industrial design, and with those manufactures into which art enters to any marked extent, will be able to feel that their work stands a chance of being sympathetically shown. That reference is made to Ghent and Paris is a hopeful sign, though the exhibits even there were not as comprehensive as they might have been. If the exhibition were to be carried through on the lines of the exhibition held at the New Grosvenor Gallery a few years ago, a great national opportunity would be lost.

Artistic Toys.—Ever since the quite early days of the war people's attention has been turned towards the art and craft of toymaking. British-made toys have been exhibited at various places in London and elsewhere, they have been *en évidence* at a number of shows, and the British Industries Fair was fairly flooded with them. It has, however, been reserved for the Whitechapel Art Gallery to provide what is in many respects the most interesting and satisfactory exhibition of toys that has been held. At all the other shows there has been some idea of selling; at Whitechapel, on the contrary, the aim is simply and solely to demonstrate what has been and is being done, and incidentally to suggest what may be done in the future. On the whole the toys shown are very promising, especially from the artistic point of view. There is a genuine effort to break away from a dull and ugly tradition and to produce objects really attractive in themselves. On the other hand, some of the toys strike one as being more beautiful than fit for their purpose. Some of the charming little models exhibited by Miss M. V. Wheelhouse and Miss Louise Jacobs, for instance, suggest that the average child could only be trusted to gaze at them from a distance, except on rare occasions when there was someone by to

see that they were treated with due consideration. That type of toy is very attractive to grown-ups, but its charms generally leave children politely cold. The work sent by the Lord Roberts Workshops, on the other hand, is for the most part eminently practical—perhaps the soldiers who produce it have a fellow-feeling with the children —but it is at the same time on thoroughly artistic lines. The workshops lend an interesting series of wooden figures designed by Mr. Carter Preston, and their exhibit includes also some "chunky" toys by Miss Chloe Preston carried out more simply, but with much the same feeling. The collection of toys sent by Mr. Vladimir Polunin, divided into three groups—the cubic, the round, and the flat—is again admirable, and many of the wooden animals, simple as they are, are extraordinarily full of life. The farmyard and windmill lent by Homeland Toys, again, are distinctively decorative. The country toys contributed by the Peasant Arts Society are rather less satisfactory, though the idea of hedges of loofah stained green is really brilliant. The toys made by the pupils of the Streatham County Secondary School, under the direction of the Misses Polkinghorne, suggest many possibilities. They seem to be the work for the most part of children under twelve, and they show that under proper guidance toymaking may be a most instructive and interesting form of manual training for children, developing not only their powers of observation and invention, but also their artistic sense. Altogether, the exhibition at Whitechapel is one which ought not to be missed by anyone concerned either with craftwork or with the teaching of children.

ENGINEERING NOTES.

The Brasher Air Breakwater.—The cost and interest on capital expended on a breakwater to safeguard jetties or buildings on the sea front against storms will usually exceed the value of the property it is designed to protect. A novel scheme suggested by Mr. Philip Brasher, a young American engineer, which seems to offer a solution was recently described and illustrated in the *Engineer* of May 5th, 1916. This was, in brief, that, instead of employing a permanent structure to arrest the seas, he proposed to rob the waves of their power to do harm by means of an air breakwater or screen of bubbles rising from the water at a suitable point off the shore and directly across the line of advance of the storms. The method has been put to the test at El Segundo, California, where it was required to protect a pier situated in an exposed position. The installation consisted of pipes 3 or 4 in. in diameter conveying compressed air to points 100 to 150 ft. beyond the pier-head. The air supply service comprised two compressors having a combined output of 2,000 cubic feet per minute. The air pressure required is just that necessary to overbalance the hydrostatic head. A pressure of 25 lb. per square inch would usually suffice, as a breakwater would not be expected to operate in depths much over 50 ft. The installation at El Segundo had fortunately been made ready for service when in January last the Pacific coast was swept by a violent storm, which did great damage to property. The waves ranged from 12 to 15 ft. high, and would have seriously injured the pier had it not been for the intervention of the air breakwater. For twenty-three hours compressed air was fed steadily into the perforated conduits under water, and the action of the rising bubbles so subdued the waves that they rolled shoreward without even jarring the wharf when the storm was at its worst. Mr. Brasher claims for his system a very flexible protective power, especially for temporary applications. Salvage work on the s.s. "Yankee," wrecked on the coast of Rhode Island, was carried on as if the ship were in a lagoon after the air was turned on in the breakwater, while seas were breaking heavily outside. The subject of the above abstract was supplemented by a letter from "M.Inst.C.E." to the *Engineer*, of June 9th, regarding the theory of water pressure involved in the process described.

The Highest Arch Roadway Viaduct in the United States.—An example of a satisfactory solution of the problem continually arising—how to construct with the available funds a structure of pleasing architectural appearance—is found in the design of the recently completed high-level bridge for roadway traffic over the Cuyahoga River gorge near Akron, Ohio. This viaduct, built of ferro-concrete, is reputed to be the highest roadway structure, 190 ft. from bed of stream to level of road. The excessive height of the piers in the Akron bridge made the problems of construction more difficult than usual. Special care in erection was taken to avoid excessive unbalanced thrusts on these piers. The three-hinged steel arch centres, with 2-in. tie rods to take the thrust, are, of course, the most economical for such a location, the centres being placed by the construction cable. The total length of the viaduct is 781 ft. 9 in. The bridge has a 24-ft. roadway and two 4-ft. footways, and provision for a single-track electric road is made for the future. As finally built, the structure consists of five main arch spans 127 ft. long between centres of piers. Each arch has two main ribs, 20 ft. on centres, supporting spandrel columns. The three high piers are hollow, rectangular in section, reinforced with horizontal and vertical steel, and the walls strengthened by horizontal diaphragms about 40 ft. apart vertically. The loftiest pier is 110 ft. high. The approaches are of exactly the same floor construction as the main arch span, similar columns to the spandrel columns, spaced 9 ft. 5 in. on centres, being carried down to the rock foundation. On the south approach the columns, because of their great height, are braced by 12-in. by 12-in. longitudinal struts at about the mid-height, and transverse struts with knee braces are also used. The bridge was designed for a uniform

live load of 100 lb. per square foot on the roadway and 75 lb. on the footway, for an 18-ton truck on four wheels, 9,000 lb. per wheel, 5 ft. gauge and 10 ft. on centres, with 30 per cent. impact, for a 40-ton car with trucks 22 ft. on centres, wheels 10,000 lb. each, spaced 6 ft. apart, with 40 per cent. impact. Wind pressure was considered at 30 lb. per square foot. The allowable unit stresses were 750 lb. per square inch compression in concrete and 16,000 tension in steel. On the foundations about 5 tons per square foot for dead load and 10 tons for the worst condition of unbalanced thrust were allowed. The maximum compression on the concrete of these piers under full live load and wind pressure is about 400 lb. per square inch. The arch analysis was made in the usual manner, two street cars and two trucks being assumed. Stresses were computed to include the effects of a rise of temperature of 15° and a fall of 60°, the rib-shortening effect being included as 16° in the 60° fall. It was found that ribs 3 ft. by 3 ft. at the crown and 3 ft. by 5 ft. at the springing line would carry the stresses. These sections were increased when the design was changed, so that the ribs as constructed are 4 ft. deep at the crown and 6 ft. deep at the springing line. Seven transverse struts 4 ft. deep with end knee braces connect the two main arch ribs. Each rib is reinforced with twelve ¾-in. square rods, with ½-in. square ties on 3-ft. centres. In computing the stresses in the main ribs when the thrust line was outside of the middle third, the stresses were found as for eccentrically loaded columns, including the steel in both tension and compression. When the thrust line was inside the middle third the effect of the steel was neglected. It will be noted that the percentage of steel at the crown is only 0·39 per cent. This is due to the excessive section used for the modified design. The floor slabs are of two thicknesses, 8 in. and 6 in. Two-way reinforcement is used between the transverse floor beams and the longitudinal stringers formed at the side-walk curb and at the side of the central depressed 8-in. slab designed to carry the future electric railway track.

The Marseilles-Rhone Canal.—This canal, now under construction, is important in that it proposes to connect, through intermediate waterways, including rivers, the Mediterranean and the English Channel, carrying barges with loads of 600 tons. That a huge national enterprise can at the present time be resolved on, in spite of the temporary difficulties arising from the war, for it means the connection by methods of transhipment with New York, London, Antwerp, Rotterdam, and Hamburg, is a marvel of national activity. The canal itself is 51 miles long from Marseilles to Arles on the Rhone. The first 5 miles is in the sea protected by a breakwater. The next section is entirely in tunnel 4·6 miles in length in solid rock. The arch is segmental in form, 41 ft. in radius, and is 72 ft. 2 in. wide, including a towing-path of 11 ft. 2 in. The depth is 9 ft. 10 in. The third division is through a long cutting to near Marignane, thence along the southern end of the Lagoons of Bolman and Barre as far as Martigues, where it will unite with an existing canal between that place and Porte de Bouc. From here to Arles another existing canal will be remodelled. As to the tunnel itself, the width is to be about six times as large as an ordinary railway double line, and 50 per cent. more in cubical capacity than the two Simplon tunnels, and nearly double that of the St. Gothard. The material excavated will be more than in any tunnel yet driven. The works, having been in contemplation for many years, are expected to be finished in the course of three years, and will cost about £2,120,000.

GENERAL NOTES.

Exhibition of Designs for War Memorials.—The committee of the Civic Arts Association have arranged for an Exhibition of Designs for War Memorials, to be held at the Royal Institute of British Architects, Conduit Street, W., commencing on Monday, July 17th, when Dr. Arthur C. Benson, M.A., C.V.O., Master of Magdalene College, Cambridge, will give an address.

British Glass.—The *Daily Graphic* gives an interesting account of a visit to the laboratories at the Institute of Chemistry, at which the representative of the paper was shown a series of articles fashioned in glass from the formulæ worked out by Professor Herbert Jackson, Chief Professor of Chemistry in the University of London. Most of the articles had never been made in this country before. They ranged from glass eyes of every shade and colour to tiny glass tubes for holding iodine, etc., for the use of the soldiers. Mr. Richard Pilcher, of the Institute of Chemistry, explained that Professor Jackson's research work had resulted in the discovery of over thirty formulæ for the manufacture of glass. The samples exhibited included such different varieties as the thick and all but unbreakable glass used for miners' safety lamps, tubes and bulbs for chemical laboratories, the blue enamel used for sealing metallic wire into glass, opal glass, glass for optical lenses, for ampoules, and many other scientific purposes. It was not simply a question of copying German manufacture. Potash, easily obtainable in Germany, was scarce, and a substitute had to be discovered. Naturally, research work of this kind is costly, and until a grant was made by the Advisory Council for Scientific and Industrial Research, the expense was borne partly by the Institute and partly by Professor Jackson himself. King's College willingly furnished every facility for carrying on the work.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

CHAIRMANSHIP OF COUNCIL.

On Monday, the 17th inst., at their first meeting in the new session, the Council re-elected Mr. DUGALD CLERK, D.Sc., F.R.S., Chairman for the ensuing year.

It was resolved that a letter be addressed to Madame Metchnikoff, conveying to her tne feelings of regret and sympathy with which the Council had received the news of the death of her distinguished husband, to whom the Albert Medal of the Society had just been awarded.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, June 29th, 1916; the RIGHT HON. AUSTEN CHAMBERLAIN, M.P., Secretary of State for India, in the chair.

THE CHAIRMAN, in introducing the reader of the paper, said that his father, Sirdar Kunwar Bikram Singh, of the great house of Kapurthala, rendered yeoman service in the days of the Mutiny. He was a man of great distinction, both as a soldier and as an administrator; he was a distinguished Oriental scholar and a master of Indian classical music; he did a great deal to spread Western learning among his people and took a special interest in the education of women; he was one of the leading men of his Province, famous for his hospitality and charity, ever coming forward with offers of loyal service to the Government, by whom his advice was frequently sought. Sirdar Daljit Singh himself had a distinguished college career, and then devoted himself to the study of religion and philosophy. On the death of his brother he took a part in public life, and had played that part with usefulness to his country and with credit and distinction to himself. He had been a member of the Legislative Council of the Punjab; he was elected a member of the Legislative Council of the Governor-General by the Punjab Chiefs' Association, and he (Mr. Chamberlain) now had the satisfaction of having him as one of his colleagues on the Council of India. He was also the author of several works on Sikhism and on the philosophy of religion.

The paper read was—

THE SIKHS.

By SIRDAR DALJIT SINGH, C.S.I.,
Member of the Council of the Secretary of State for India.

It is a very big and difficult task to tell in one paper all about such "a singular nation," as Sir John Malcolm calls the Sikhs, the origin of their religion, the religion itseif, the lives of the ten Gurus who contributed to found it, the growth and history of the Sikh kingdom, its wars and constitution, and the part this people has played in the history of the Indian Empire down to the present day. But as the title of this paper is "The Sikhs" I have to include everything. I shall, therefore, make no attempt to say anything in detail, or to discuss anything, but just tell a sort of story from the beginning to the end. The paper may form, at all events, an introduction to a large subject, which should be called, "The Sikhs: their Religion and their Political History"; and as such I respectfully and with much diffidence offer it to this distinguished Society.

A RELIGIOUS BODY.

"Sikhs are excellent fighters." In these four words one may sum up all that is generally known of the Sikh people. But it is not the essential fact about them. They are, in the first place, devout disciples of a religious teacher, who in the process of evolution was the latest and most enlightened given to India. It was this circumstance, coupled with the true religious spirit of self-sacrifice aroused later by the tenth or last of their Gurus, that turned almost the whole sect into a nation. "Disciple" is the

meaning of the name they bear. Perhaps there could not be a better word than this. Customs, ceremonials, social and other laws had become so predominant a feature in almost all the religions of the time that the spirit was lost in form and had created barriers, even on the spiritual plane, that separate man from man and race from race. The very word Sikh is itself a symbol of self-surrender, giving at once an idea that religion is not a thing of outside world, but of heart, and not of form but of soul. The Sikhs consist, in fact, of two classes: (a) Peace-loving believers, to whom the name was first applied, and who are ignorantly grouped with the nebulous mass of Hinduism; and (b) the warriors, properly called "Singhs," a word meaning lions. The former constitute the field of recruitment for the latter. So vital is the religious spirit among them that one cannot become a Singh unless one receives a special baptism, called the *pahul*; and there is equally a form of baptism for the Sikh, known as Charan Ghal. Moreover, all who receive baptism, whether Aryans or aborigines, spiritual Brahmans or low-class "Shudras," Indians or foreigners, are alike admissible, and henceforth treat each other as members of the same family.

Numbers and Occupation.

It is difficult to estimate their exact number. Census reports put them at about 2,500,000, but take account of Singhs only. If we add those Sikhs who are classed as Hindus, the number must probably be doubled. The occupation of the Sikhs is, generally speaking, either the sword or the plough. It is a curious fact, and as old as the use of arms in India, that agriculture has always been held to be the proper means of livelihood of the warrior, and that from the best agriculturists the finest soldiers have always been drawn. Three-fourths of the Sikh population are tillers of the soil, and perhaps the best in India. In their proper home, the Punjab, they own nearly one-fourth of the cultivated land. Self-respecting and sentimental, the Sikh is a most willing and hard-working husbandman; and he is equally enterprising. He will go to any part of the world where he can find good labour; and so he is to be met with not only in the other Indian provinces, but in Afghanistan, China, Southern Asia, and America. Yet, wherever he may be, and whatever he may be doing, the Sikh cannot forget his sword and the spiritual tradition of his forefathers. The first sound of a call to arms will stir anew in him the spirit infused by his spiritual father, Guru Govind Singh, and find him ready to maintain that tradition at the cost of his life.

Number in the Army.

In normal times one-fourth of the Indian Army consists of Sikhs, and they have been described by such masters of the military art as Lord Roberts and Kitchener, and regarded by the whole administration of His Imperial Majesty, as the flower of the Indian fighting forces. Sir Lepel Griffin said: "The Sikh is always the same; in peace, in war, in barracks or in the field, ever genial, good-tempered and uncomplaining; a fair horseman, a stubborn infantry soldier, as steady under fire as he is eager for a charge. Hardy, brave, and of intelligence too slow to understand when he is beaten, obedient to discipline, devotedly attached to his officers, he is unsurpassed as a soldier in the East. There are many warlike races subjects of the Queen in India, but of these the Sikhs indisputably take the first place."

In trans-frontier skirmishes, in Afghanistan or China, Egypt or Abyssinia, within the boundaries of the Indian Empire or outside it, there has not been a single campaign in which Sikhs have not had the honour of fighting under the British flag and not kept up the worthy traditions of their Khalsa.

Early Conflicts.

The period from the middle of the fourteenth to the middle of the fifteenth centuries of the Christian era was remarkable, in the East as in the West, for political and mental upheavals, and for that religious and social awakening which always follows a time of storm. In Europe the Mohammedans had conquered Turkey and Greece, and had penetrated into Thrace and Hungary; in Asia Taimur had spread his kingdom from Siberia to the Arabian Sea, and from the Ganges to the Hellespont. There had been many wars and some great discoveries. For Europe the struggles of Luther and Calvin heralded the dawn of a new age of reform and reconstruction; and in India the monotheistic but quiescent teachings of saints like Kabir and Ramanand began to loose the fetters of superstition and priestcraft. The Punjab was a principal scene of conflict. Now known as the spear-head of the Indian Empire, it lay in the path of every invader; and in the fourteenth century frequent disturbance and bloodshed had lowered the moral standard and left a state of confusion. The fruit of this sowing began to be reaped in

the century that followed. The third day of the light half of the month of Baisakh (April-May) in the year 1469 A.D. is the first day of the history of the Sikhs. On that day the founder of the religion, Guru Nanak, was born at Talwandi, now called Nankana after the Guru's name, in the district of Lahore.

It is important to mark the significance of this event, and for that purpose to realise the state of society in which his teaching was to come as a new and great moral impulse, being distinct from any that had preceded it and singularly modern in certain aspects. The ancient "Dharma"—for religion is no appropriate name for it—had included all that is meant by duty and law as well as worship, from the most ordinary obligations of society and the household, sanitary precautions, customs and ceremonial rites to the national ideal, and from art, literature and daily prayers for the common human wants to the highest philosophy of the Vedanta. Such a system looks grand, nothing could be finer. But it is reduced to practice with difficulty, and the difficulty of adapting such a system to all times and civilisations is still greater. Nor could the religion of the invaders at once command sympathy. The need was keenly felt in the Punjab for a religion that should be simple, pure, and free of superstitions and dogmas based on morality; and this it was left for Guru Nanak to found.

Guru Nanak.

Guru Nanak was the only son of his parents, Baba Kalu and Tripta. Kalu, a Hindu and by caste a Kshattriya, held the respectable post of accountant in his village of Talwandi. Guru Nanak promised preternatural gravity from his childhood; and his retiring and meditative temperament, indifferent to the petty life around him, was a constant cause of anxiety. Trying to turn the channel of his thought, Kalu once gave him a sum of money and advised him to go to town and buy something that might be sold at a profit in the village. The future Guru had not gone far on his errand when he met a party of faqirs whom extreme hunger had deprived of the power of speech. He hurried to obtain provisions and feed the dying faqirs. The money that had been intended for some bargain was all bestowed in this work of mercy and compassion; and, when questioned by his father, Nanak said: "No bargain could be better than I made, for it is with God, not to perish with this body but to be reaped in the world to come." Kalu's anxiety continued, and he got Nanak married at the age of sixteen. When this availed nothing, he sent him to his only sister, Nanki by name, who was devoted to him, and whose husband, Jai Ram, procured employment for him under the Sultan Doulat Khan Lodhi. In vain. The Guru did his duties honestly, but he spent his leisure in the company of holy men or in deep reflection. At the age of about thirty-four, being then the father of two sons (Sri Chand and Lakhmi Das), and being a man of ripe experience and thought, knowing what it was that he had wanted, Nanak began to preach his gospel. He made four great tours in doing so. Two of them were within the boundaries of India, embracing all parts of it from Karachi to Assam and from Kashmir to Cape Camorin. The others covered Tartary, Turkey, Arabia, Afghanistan, Kandahar and Tibet, with Ceylon and some of the southern islands; and in most of these countries devoted disciples of the master are still found. It is characteristic that in these journeyings he was accompanied by his first disciples, Mardana, the musician, and Bala, who were so inseparably his associates that in all old paintings of the Guru they are included. Mardana was formerly a Musalman and Bala a Hindu Ját. Music took a conspicuous part in his life, his devotions and his meditations; and it is essential to the Sikh worship. In his later days, completing a long life of devoted effort, he settled down with his family near Batala, on the banks of the Ravi, one of the "five rivers" of the Punjab, and there expounded his doctrine to thousands who came to him. There, too, he devised and consecrated rites of morning song and evensong—rites of singular beauty and the most poetic appeal. Imagine the daily scene. Immediately before the sun appeared at dawn, the morning song was intoned by a reverent host. It preceded the service, as if invoking the Spiritual Sun to shed His rays and illumine the darkest chambers of the heart; and so, as the light came, it inspired a glad uprising of the spirit. At nightfall, again, when the sun's last beam was withdrawn, the hymn of the Reh Ras—the Right Path—moved the worshippers to inward contemplation. There, in 1538, the Blessed One passed away. That he was revered by Hindus and Mohammedans alike is plain from the fact that the sheet which covered his body at the time of his passing—for there was only the sheet left to them, the body not being found—was divided between these adherents, the one half to be buried by the Mohammedans and the other burnt by the Hindus according to their respective customs.

His Unique Teaching.

What were the distinctive features of this great teacher's gospel? Where we find a purely spiritual religion, it must always be difficult to distinguish it from others and to discriminate between them, for, after all, the truth is universal, and that which is not essential everywhere is not true. Guru Nanak taught that there is nothing higher or better, nothing more exalting, nothing more peaceful, nothing more full of joy and bliss, than to love God and to surrender oneself to Him by devotion.

"Sing and hear and put His love into your hearts:
So shall your sorrows be assuaged, and ye be absorbed in Him, who is the abode of happiness."

Of God he said: "He is one, His name is true, He is the Creator, the Primordial Being, devoid of fear and enmity, timeless, unborn, self-existent." These are universal truths. But there were important respects in which the Master's teaching was unique in India. In the first place, unlike the saints who had preceded him, he taught that good men were not to withdraw themselves from the world as the faqirs did, or to shirk those duties which Nature had laid upon them, but were so to live in the world, "as a lotus in water," that their virtue should subdue the evil in it, and, by "losing self in the Universal Self," transform the world's misery into happiness. Then, distinctively from Hinduism, he prohibited all kinds of worship except that of the Absolute, the Dweller in All Beings, and preached the equality of men, abolishing the caste system and founding a democratic brotherhood. He held that the true way of self-surrender is in service done to others, and that the key to all such service is a pure and high morality. Living the good life, men were to love the world because it is God's, and to love each other because God is in all men and they in Him. Ceremonies, laws and customs, he said, are the expression of passing phases of the human mind. He saw that they cannot suit the changing conditions and civilisations of different ages, and that they are valuable only as they declare at any time the pure moral law. The form is always changing, the spirit is eternal. This highest axiom of philosophy he found applicable to daily life; for, as the moral law, devotion and the selfless life are alone matters of the spirit, he regarded everything else as form, and, therefore, as liable to change according to the needs of the time. I think you will agree that there was something very remarkably modern and great in this outlook, something at once noble and practical, destined to affect India profoundly if it could prevail.

Some Sayings of the Master.

You will wish to hear some of the sayings of such a teacher, and of the stories told of him, recorded by his immediate successor. When he was seven years of age his father, Kalu, wished to celebrate the ceremony of investing him with the sacred thread of the Hindus, which can be worn by three higher castes only. In the midst of an assembly of relatives and friends, and in presence of the great Brahmin priests, he caused astonishment by refusing to wear the knotted thread of cotton, which was perishable and served no purpose. His protest is chronicled in verse which I translate—

Let the staple of your life be mercy, spun into a thread by contentment, strengthened by truthfulness, knotted by self-control.
Such a thread is needed for the soul, O priest: if you have such a one, invest me with that.

The saying lays down the four cardinal virtues that Nanak preached, "without which life is in vain" and "devotion impossible." There is a story that illustrates both his attitude to caste observances and his thought of right living. When staying in Emnahad at the house of a disciple called Lalo, a carpenter, he declined the hospitality of one Malik Bhago, the governor of the place. Insisting, the governor remarked that his food was surely better than that of a man of lower caste; but the Guru, with his usual calmness, replied that on the contrary the carpenter's food was much the purer, for it was rightly earned, while the Malik's was no better than blood sucked from the poor. His preaching may be illustrated by two quotations (sayings addressed to Mohammedans and Hindus respectively). To Mohammedans he said on one occasion—

Make kindness thy mosque, sincerity thy prayer carpet, what is just and lawful thy Koran,
Modesty thy circumcision, civility thy fasting; so shalt thou be a Musalman.
Make right conduct thy kaaba, truth thy spiritual guide, good works thy creed and thy prayer,
The will of God thy way, and God will promote thine honour.

When invited to share the worship of the Hindus at Jaggannath, he declared a purer sense of ritual and a disdain of idolatry in this hymn—

The sun and moon, O Lord, are Thy lamps; the firmament thy salver, the orbs of the stars the pearls enchased in it.

The perfume of the sandal is Thine incense, the wind is Thy fan, all the forests are Thy flowers, O Lord of light.

What worship is this, O Thou Destroyer of birth? Unbeaten strains of ecstasy are the trumpets of Thy worship.

Thou hast a thousand eyes and yet not one eye; Thou hast a thousand forms and yet not one form;

Thou hast a thousand stainless feet and yet not one foot; thou hast a thousand organs of smell and yet not one organ. I am fascinated by this play of Thine.

The light which is in everything is Thine, O Lord of light; from its brilliancy everything is brilliant.

By the Guru's teaching the light becometh manifest.

What pleaseth Thee is the *real* worship.

O God, my mind is fascinated by Thy lotus feet as the bee with the flower: night and day I thirst for them.

Give the water of Thy favour to the sarang Nanak, so that he may dwell in Thy name.

Before his passing away, and while in perfect health, the Guru selected his successor, a recent convert whose devotion and fidelity he had quietly marked; and by this choice he was the first Indian teacher to honour the fittest without respect to rank or parentage.

The Guru Succession.

A saintly line of Gurus, making ten in all, watched over and guided the development of the new religion, which presently declared against such specific errors and was sharply defined by events. Space and time being too short, I cannot dwell on the lives and sayings of each one of these; I can only try to show how far, besides imparting spiritual instruction as they followed in the footsteps of their Master, they affected the social, political and literary world around them. The religion owed to Guru Angad, the first of them, the invention of the Gurmukhi character, which has proved to be best suited for the Punjabi language. The first book that its inventor wrote in this script was the life of the Blessed One, from the lips of Nanak's lifelong companion Bala. The third Guru, Amar Das, forbade suttee and upheld the marriage of widows, reforms that make a landmark in Indian history. To the fourth, Guru Ram Das, the Moghul Emperor Akbar gave that piece of land at Amritsar, "the Pool of Immortality," where now stands the Golden Temple, the Mecca of the Sikhs. The fifth of the line, Guru Arjan, compiled the Granth, the sacred book of the Sikhs, enshrining the sayings of himself and his predecessors; which to this day both serves and is respected as "the living Guru" for purposes of spiritual teaching. He was a great supporter of education, and from him emanated the system of primary education in the form of "Dharamsalas" dealt with later on. So far, there was no hint of a warlike spirit in the new religion.

Nationality.

But at this time the Moghul rulers began to show signs of a different policy, and the gulf between the ruler and the ruled had widened to its full width, into the details of which I need not enter, but which led the sixth Guru, Har Govind, to take up arms; and it was now that, under the stress of events, the latent spirit of nationality first awoke, and peace-loving men began to change into a militant race. The spiritual leadership was continued by the Gurus Har Rai, Harkisan, and Tegh Bahadur; and it was not until the days of the famous tenth Guru, Govind Singh, that the Singh warrior class was constituted.

A Great Martyrdom.

Guru Govind Singh was the son of Tegh Bahadur, whose martyrdom directly furnished the motive for that development. The Emperor Aurangzeb had required that the Hindus of Kashmir should embrace his own faith, and had been answered that they would be guided by Guru Tegh Bahadur. The Guru was at once summoned to Delhi. He knew that he must sacrifice himself to save them; but, wishing before his departure to test his son, then nearing his majority at fifteen, and to see if he had the true temper of a leader and successor, he asked Govind what he thought. The boy answered, nobly, that there could be nothing better than such a sacrifice, and the Guru set out for Delhi with a light heart, satisfied. At Delhi two memorable things befell. One was the utterance of a remarkable prophecy, which was to knit a close tie between the Sikh people and the English when it was remembered long after. The Guru, as he stood one day on the roof of the house where he had been lodged, was accused of gazing at the harem of the Qazi across the way. He answered: "I look towards the West"; and, when asked what he meant by this, he said: "I do so, because it is from the West that a

people must come, a nation of men wearing hats on their heads, who shall bring with them justice, prosperity and peace." The other event was his death, the manner of which was very striking. A miracle had been demanded in proof of his claim to be a divine teacher, and he had declined that test; but, being imprisoned now and sick of daily torture, he said, "I will show you a miracle." In the presence of the Emperor he wrote some words upon a sheet of paper, folded it, tied it with a thread round his neck, and then bade them bring the executioner with his sharpest sword to behead him. His head fell, severed at once from the body. But what he had written was these words: "I give my head but not my religion." The superbly ironic miracle was a portent. Estranged once for all, the Sikhs under Govind Singh, and later on under different warrior leaders, were committed in defence of the faith to form their nation and to break the power.

Institution of the Pahul.

I pass over the years of Guru Govind Singh's preparation for conflict, and come to that most important event in the history of the Sikhs which is known as the Great Test, and to the organisation of the "Khalsa." Determined to evolve out of this religiously united people a nation of warriors, he called a huge meeting of the Sikhs on the first of Baisakh (April 12th), 1698. It was drawn from all parts of the Province, and it met in an extensive plain, in the midst of profuse verdure, in one of those beautiful valleys which lie at the foot of the lower range of the Himalayas. Out of a tent pitched in one corner appeared the Guru with a drawn sword in his hand, and demanded for the establishment of the kingdom of righteousness the head of one of his Sikhs to be sacrificed. A man instantly arose, and with folded hands said, "Yes, O Lord, I am at your service. Do with me as you please." This brave soul was Daya Singh, a Kshattriya by caste. The Guru led him inside the tent. A moment later he appeared again with the sword dripping blood. When he demanded another head the ordeal was of the severest; yet a second man, Dharma Singh, responded to the call. Three times more the Guru made his demand, and three more heroes offered themselves—Himmat Singh, Mohkar Singh, and Sahib Singh, all three of low caste. There were many others ready to sacrifice their lives for the true cause, but the Guru did not appear again. Soon afterwards the curtains of the tent were drawn back, and, to the great astonishment of the assembly, there stood revealed the five chosen ones, typical of that region of five rivers of which the Punjab was to be formed. Addressing the multitude, the Guru said: "Heaven is but a property of noble souls like these; nevertheless there is work for them yet in this world. I wished to find out, in the presence of a full meeting of my Sikhs, what each individual was capable of; and we have found that out."

This ordeal was followed by a great Durbar, in which the first ceremony of the Pahul baptism was performed. An iron vessel was brought, some water and sugar were put into it, and these were stirred with the point of the sword while the Japji and a composition of the sayings of Guru Govind Singh were recited. The Guru called this mixture *shirbatt*, as Amrita—ambrosia. Some of it was sprinkled on the heads of those first five, and the rest was drunk. Then he in turn had himself baptised by the five. In virtue of this ceremony they became members of an equal brotherhood; and they were invested with swords, and stood vowed to their faith as sons of the Guru. The spirit of their Guru had entered into them. By companies of five, all who offered themselves were afterwards inaugurated; they were hailed as Singhs, or lions, warriors or Kshattriyas without distinction of caste, a name which had been used by Hindu Kshattriyas or warrior caste alone; and thus was formed the Khalsa, or fighting commonwealth of the Sikh nation. In less than a fortnight 80,000 Sikhs had flocked around the Guru as Singh. Later on a few Mohammedans and a large number belonging to the low caste considered as "untouchable" amongst Hindus were also baptised. The fact that even under the circumstances a few Mohammedans accepted the religion is remarkable when arms were used for conversion to the faith of the rulers. His purpose and the pure creed of Guru Nanak were proclaimed in an eloquent exhortation; and, by way of marking a clear outward distinction from Mohammedans and Hindus alike, not only were certain customs and insignia forbidden to them, but as warriors they were enjoined to wear "the five K's"—namely, the *kes*, or uncut hair; the *kripan*, or dagger; the *kanga*, or comb; the *kuchh*, or short breeches ending at the knee; and the *kara*, or iron bangle. They were to worship neither idols nor the dead, no Hindu tomb and no grave, and abstain from the use of tobacco. Finally, they were to greet each other with a special salutation, meaning "The Khalsa is of God and His is the victory."

Govind Singh's Achievement.

This was the starting-point of the Sikh nation. Govind Singh had created a force which soon proved formidable, even against the might of Aurangzeb. In the course of more than thirty years, during which he was the spiritual head of the Sikhs, he commanded in many battles and won some signal victories, which led to the rise of the Khalsa as a commonwealth and a power, and were one cause of the fall of the Moghul Empire. Historians all agree upon his genius. He was the greatest teacher and reformer of his age, a great organiser and leader in war, and an ideal of self-sacrifice, self-denial, and modesty in his relations with the brotherhood he had created. It is said that a Sikh once brought to the Guru, as a gift, a pair of wristlets set with precious stones, worth a hundred thousand rupees. Govind Singh would not accept the offering. At the moment he was seated on the bank of a river, and on the Sikh insisting he put the jewels on, but a few minutes later dropped one of the wristlets into the stream. Anxious for its value, the devoted Sikh announced a reward of a thousand rupees for any man who should recover it. A diver came forward. Before entering the water this man asked the Guru to point out the exact spot where it had fallen; and thereupon Govind Singh, by way of doing so, cast in the other wristlet after it. As for the spirit of self-sacrifice, we have seen how it appeared in him under the test of his father. And what sacrifices could be greater than he suffered in the loss of his four sons? When that unhappy event reached his ears by which two of the younger were buried alive at Sirhind, not a single tear was seen in his eyes, and the only words he uttered were, "Thy will be done." This most cruel episode was never forgotten by the Sikhs; and Sirhind was for a long time the chief point of their warlike attacks, until it was finally conquered and destroyed. The original town still forms a part of Patiala State. The fact is a sufficient confutation of the vulgar fiction that the purpose of Sikh belligerency was plunder. They, too, exhibited the spirit of self-sacrifice. Govind Singh had so conspicuously imparted it to his followers that, with regard to certain Sikhs whose skin and flesh were torn by executioners under the orders, a Mohammedan writer says: "It is singular that these people not only behaved firmly during the execution, but they would dispute and wrangle with each other who should suffer first; and they made interest with the executioner to obtain the preference." In the battlefield every Sikh bore himself fearlessly, repeating the saying of the Guru—

> O Lord, give me only this blessing, that I may never go back from doing virtuous acts . . .
> And when I go into the field that I may be killed there, and my firm belief be in victory.

Such was the national spirit created by Guru Govind Singh, and yet of these followers he said—

> Verily I am but one adorned by them; otherwise there are millions of poor men like myself.

Besides all this, I have to complete his picture by a reference to fostering services to the Hindi and Punjabi languages. He was an excellent poet of Hindi as well as Persian. In Persian he wrote the famous letter in verse to Aurangzeb known as "Zuffer Nama." In Hindi there are a few books and a good many verses written by him. He was so fond of poetry that he had always with him a school of poets, who translated numerous Hindu Shastras and some Persian manuscripts into Hindi verse to make a literature of their own. The Granth of the tenth Guru contains all such poetical works. It is notable that music and poetry have been so intrinsic to the religion that these arts are a predominant feature of all the Sikh ruling courts.

The last of the Gurus died peacefully in 1708, in the midst of his devotions at Nadir in the territory of H.H. the Nizam, where later Maharaja Ranjit Singh erected the tomb, and H.H. the Nizam's Government assigned a sumptuous Jagir for the upkeep of the same. The value of his Pahul was to be recognised in due time by the British Government, when it was made compulsory upon all Sikhs entering the Indian army; and I desire at once to acknowledge that this recognition has been largely instrumental in maintaining the spirit of the nation.

Rise of the Khalsa.

On the death of Guru Govind Singh, the Khalsa was led by an intrepid warrior named Banda, who for a time made himself master of the region between the Sutlej and the Jumna. But it is chiefly important to note the rise of that organisation. Guru Govind had said: "The Khalsa arose from the Guru, and the Guru from the Khalsa." Again: "The Guru shall dwell with the Khalsa; and wherever there shall be five Sikhs gathered together there shall the Guru be also present." There came into existence a sort of a system of a cabinet or national council, which, having been founded by Guru Govind himself, with a quorum of five,

replaced his personal authority in it, and which sometimes elected a leader called the Jathaidar. When this met, the Khalsa had an opportunity of expressing their feeling as to current events; and the cabinet's decision was known as the Guru Mata. Sir Charles Malcolm says of the institution of this cabinet and the Guru Mata that: "It furnishes a fresh proof of the comprehensive and able mind of this bold reformer, who gave by its foundation that form of a federative republic to the commonwealth of the Sikhs . . . by giving them a personal share in the government and placing within the reach of every individual the attainment of rank and influence in the State." There is a significant story of the election of a Jathaidar, Kapur Singh, and the high appreciation for the sense of justice shedding a humane light upon a period of cruel trial. The national council being assembled, it was said: "We should elect such a man as will see all parties with the same eye." In a recent battle Kapur Singh, carrying a water-skin, had been seen giving drink to the wounded, and it had been noted with admiration that in doing so he did not distinguish between a Sikh and a Mohammedan. He was elected for this magnanimity. But it is to the second of such chosen leaders, Jassa Singh, with his contemporary Ala Singh, that the credit of actually founding the kingdom of the Punjab must be given. The Sikh commonwealth at this time was divided into twelve families, clans or *misls* as they were called, and Jassa Singh, belonging to one of these, held together a confederacy on the northern side of the River Sutlej; while Ala Singh stood in a similar relation to the *misls* of what are now known as the Phulkian States on the southern side. Jassa Singh, the founder of the ruling house of Kapurthala, now the premier ruling State on the trans-Sutlej side of the Punjab, commanded universal respect among the Sikhs; and even the family of Ala Singh considered it an honour to be baptised at his hands. His was a great achievement. Compared with the romance, the bloodshed and the heroism of that period, there is nothing in the history of Scotland before the Union that can be considered on the same scale, for Scotland had but only a single though an inveterate enemy, but the Punjab was the high road of every foreign invader and the first brunt of the onset fell upon the Sikhs.

The Kingdom Founded.

Jassa Singh's outstanding bravery and political skill founded the kingdom of the Khalsa at Lahore in 1753. And for the first time coin of Khalsa was struck in the mint of the Moghuls, bearing the inscription, "Coined by the grace of the Khalsa in the country of Ahmud, conquered by Jassa the Kallal"; and he was the first ruler to be called by the Sikhs their king. Thus the force created by the genius of Guru Govind Singh began to come into its own, and even the relentless energy of Nadir Shah and Ahmad Shah Durrani could not subdue it. It was at this time that the Golden Temple was rebuilt at Amritsar.

Ranjit Singh.

On the foundation laid by Jassa Singh, Ranjit Singh, the Lion of the Punjab—who began to rule at Lahore in 1799—built the complete sovereignty. The policy of Maharaja Ranjit Singh, who belonged to the Sukarchakia *misl*, is notable in these respects—that among the officials of his Court, high and low, he had both Hindus, Mohammedans and Sikhs; that in his armies there were officers and men of all ranks belonging to the three religions; and even Europeans. By the end of 1834 he had not left a trace of Afghan authority east of the Indus, and ruled over a kingdom with an area of some 145,000 square miles.

At the time of Ranjit Singh's accession only three *misls* commanded much influence. On the northern side of Sutlej two of them had founded independent States, namely, the kingdom of Lahore and Kapurthala, the latter ruled by Fateh Singh, a descendant of the great Jassa Singh and a chieftain of whom Sir Charles Metcalfe said that he was "the equal, if not the superior, of Ranjit Singh in rank and power." The third, on the southern side, had founded under Ala Singh the State of Patiala, together with the States of Nabha and Jindh, known as the Phulkian States. When Ranjit Singh was on the threshold of his career, in 1806, the East India Company became involved in the second Mahratta war, and these three States were perhaps the first in Northern India to make alliances with the Company. There you saw the effect of the prophecy uttered by Guru Tegh Bahadur. The result of these alliances, and of the rout of Jaswant Rao Holkar, the Mahratta chief, was to free the hands of Ranjit Singh for those campaigns in which, with the powerful aid of Fateh Singh, he wrested the provinces of Multan, Kashmir and Peshawar from the Afghans.

Annexation and the Mutiny.

After the death of Ranjit Singh a state of anarchy prevailed in the Kingdom of Lahore,

and constant troubles obliged the British administration to annex that kingdom, while the other States continued to exist independently. The policy of Lord Dalhousie by admitting them to the British Army as valorous friends, and the trust thus placed in them, enlisted the martial spirit of the Sikhs almost immediately on the side of the British. By some critics this policy was questioned; but in 1857 the Mutiny put it to a supreme test, and the Khalsa did not waver. The Kapurthala and Phulkian chiefs were the first leaders to take the field against the mutineers, and their example was followed throughout the Punjab. Sir Lepel Griffin acknowledges freely that they acted "on the very first alarm, and without waiting to see whether the omens were auspicious or hostile." The promptness and entire devotion of the Patiala and Kapurthala chiefs have, I believe, endeared their memory in particular not only to Englishmen, but to all Indians who appreciate the blessings of peace, prosperity, and freedom. They put all their resources, without reserve, at the disposal of the British authorities, and when the Punjab declared itself on the same side the issue ceased to be doubtful. To the mutineers the fall of Delhi was a death-blow. When you consider that eleven years only had passed since the annexation, and that this had been preceded by two wars, I do not think you will underestimate such a proof of attachment and spontaneous loyalty.

The Sikh Civilisation.

Let me sketch, briefly, the civilisation which had begun to shape itself among the Sikhs at this time. Sikhism is eminently a literary religion. As we have seen, the Sacred Book compiled by the fifth Guru, and supplemented by the ninth, contains hymns of singular beauty, the singing of which forms the most important part of our worship. They are mostly in Punjabi, though the hymns of Guru Nanak include a number in Rajasthani and Sindhi, and a few in Persian. The original manuscript is preserved at Kartarpur, in my own district. This Sacred Book, carried at the head of all Sikh regiments, is considered as a living Guru. Besides this sacred volume, the sayings and works of Guru Govind Singh, and the compositions of all his chief poets, are collected in another book, which is generally spoken of as the Granth of the tenth Guru. They include not only hymns, but regular compositions in the language of Hindi classical verse. A system of education introduced by the Gurus is noteworthy. In connection with religious centres called Dharmsalas, established in every town, and even in every village where the majority of the population were Sikhs, there was a learned teacher whose duty it was to impart secular as well as religious instruction. This system corresponded to what in modern times is called free primary education. There was also a system of tribunals, the Panchayats, deriving its name from the quorum of five or "Punch" fixed by the Guru for the National Cabinet, a system which the British Government has lately been disposed to revive. The functions of this tribunal were civil and judicial. But the greatest proof and test of our civilisation is its social effects throughout the Province. It is only in the Punjab that you may see to-day a free intercourse between Hindus and Mohammedans in eating and drinking, and that the social life is cosmopolitan. Whereas, indeed, even a Brahmin of one province will not eat with a Brahmin of another province, and elsewhere one man fears to be defiled by another's shadow.

Art.

Of our arts, the chief example is the Golden Temple. How shall I describe that glory of architecture? It stands four-square, reflected on all sides in the waters of the sacred pool, a shining splendour of gold and marble. A marble gate and bridge form its noble approaches. From the picture I show, you will see that the style is Mohammedan, with Hindu details, and that the high plinth is of marble, with a golden superstructure topped by minarets. In this temple only the Sacred Book is read, and the orisons for dawn and sundown are daily sung. As the light of each day breaks there are thousands of worshippers, from the poorest to the richest, waiting to hear the first verse when the Book is opened. The scene is wonderfully solemn and uplifting. Then consider the historic interest of the temple's surroundings. On the outer margin of the pool there are houses built by the *misls* and by other leading men of the past. Devotees come and sit between this façade of houses and the water, where a broad marble path goes round the "Pool of Immortality." The temple is radiant under the Indian sun. And when the pool is illuminated with floating lamps for the Dewali Festival, and you see it gleaming beneath a canopy of stars, it leaves one of those ineffaceable memories which all men cherish.

The Dominions.

Just a word to compare the Sikh dominions as a whole with the present Province of Punjab.

As I have said, the Sikh dominions extended from Delhi to the Khyber Pass, and from Multan to the Kara Koram Mountains. It included the States of Jammu and Kashmir, the district of Hazara, Kohat and Bannu, and also the district of Derajat. The whole cis-Sutlej side was under the rule of the descendants of Phul. On the northern, or trans-Sutlej side, a part of the Ludhiana, Jalandar, Ferozpur and Amritsar districts was under that of the Kapurthala house, descendants of Jassa Singh; while the rest was known as the Lahore Kingdom under Maharaja Ranjit Singh's government. As it now stands, the whole region is divided into three parts. Two, the Punjab proper and the North-west Frontier Province, are under British administration, while the third forms the State of Jammu and Kashmir.

States.

Within the States administered by the British Government, the Phulkian and Kapurthala houses still enjoy their ruling powers; and two more ruling States, though much smaller, are recognised besides, viz., Faridkot on the trans-Sutlej side and Kalsia on the other. The total area of these various ruling States is about ten thousand square miles, and their military strength is seven thousand with 152 guns. This, from the Mutiny down to the present world crisis, has always in time of need been put at the disposal of the Government, together with every other resource of these independent States.

Aristocracy.

Besides the ruling houses, there were at the time of the annexation a host of smaller chiefs or large landholders, Jagirdars, together with some nobles of Ranjit Singh's court. They now enjoy nearly the same privileges, forming the famous aristocracy of the Punjab. They are the social and political leaders of the Province, and have never failed to serve in times of war and peace alike. It was due to Sir Charles Aitchison, one of the ablest Governors the Punjab has ever had, that this nobility was brought together, along with the aristocracy of Hindu and Mohammedan subjects, to form a class whose influence being thus maintained should be increasingly useful in days to come. He founded at Lahore the "Chiefs' College," to impart education to the sons of this nobility and to fit them for the work that lay before them. The students of the college now occupy places of distinction in Government services and Councils, and prominent positions on public platforms. Recently we have formed the Punjab Chiefs' Association, the principal objects of which are to bring about a better feeling between the ruler and the ruled, and to safeguard the interests of the class in particular and of the Province in general. In answer to an address from this association, Lord Hardinge said the other day: "It is no small consolation to think that I can count for understanding and support upon your association . . . to co-operate in the furtherance of the policy of the Government."

Education.

I have already noted the interest taken by the Gurus in literary and educational propaganda. I have also mentioned the system of free primary education founded by the first Guru himself. Up to the time when the Lahore kingdom was established that system had not shown any results worth mention, except that the whole population was accustomed to the Gurmukhi character. Under Rangit Singh it was improved by starting schools here and there, including even a girls' school, which existed at the annexation, as remarked by Lord Lawrence. The time had now come to reap the seed thus sown. Alongside the Government and other educational institutions of the Punjab, the Government has enabled the Sikhs to develop an extensive system, though they constitute a minority of the population. We have a national residential college at Amritsar, affiliated to the Punjab University; colleges in each Sikh State; and over 100 high schools, the number of which is continually increasing. These schools, managed and taught by Sikhs, are under the control of a Sikh educational conference, which meets annually and which has always been able to rely upon receiving help from the Government. It is noteworthy that, save at some places in Mysore and Travancore, female education in India is greatest among the Sikhs. We have a very large residential school for girls at Ferozpur, with accommodation for at least 500 or 600 pupils, and more than twenty-four other Sikh girls' schools exist in the Province. It is hardly necessary to say that, but for State help, these developments would have been impossible to a small community like ours. At the same time our students share very fully in the benefits of the Veterinary College at Lahore, and the Agricultural College at Lyallpur.

Finance and Agriculture.

In the first place, it is difficult to get the exact figures of the revenue of those days, and, secondly,

the system of revenue being different it is so difficult to compare the past and present revenues of these provinces. There is, however, no question to the fact that the revenues have increased immensely. This augmented yield is due to enormous material benefits conferred on agriculture, for which source of wealth the Province is most famous. In the first place, irrigation by wells alone has increased by 60 per cent., if not more. The total number of wells is over 300,000, and new ones are being continually sunk. Besides these, there have been works of irrigation costing £14,000,000, and doubling the produce of the Punjab. There are some 18,000 miles of canals and distributing channels. The value of the cultivated land has increased threefold; and new land, brought under cultivation by colonisation schemes, has provided more than 100,000 peasants with fertile farms. These schemes tend to make the Province the granary of India. Significantly, it is in the Punjab that we have the headquarters of the longest railway line in India, the North West Railway managed by the Government.

Sikh Loyalty.

The story of Sikh loyalty to the Empire deserves to be written at greater length than for such an occasion as this. You will allow it to be one of the brightest chapters in Indian history. I remember hearing my father—who, with his brother, the then Maharaja of Kapurthala, led the Kapurthala forces in the Mutiny—describe the enthusiasm which prevailed throughout the Sikh world, every man filled with the zeal of the Khalsa; how eagerly they rallied and with what energy they fought. It left an indelible impression on my mind.

There was another great revival of fighting fervour in the second Afghan War, and you will recall, in connection with the Chitral Expedition later, that heroic defence made by a handful of Sikhs at Saragarhi. Some twenty men were surrounded in a small fortress by several thousand Afghans, against whom they had to guard a store of munitions. Their position was hopeless, but they did not surrender. Every man died at his post. The last of them, turning from the gate when he had fired his last cartridge, went into the store-room and blew up the fort, dying rather than leave it to the enemy. A memorial to these gallant heroes, built by the Government, now stands at Amritsar, and another at Ferozpur. I was at Simla when the present war broke out, with the Maharajas of Patiala and Kapurthala, and the other Maharajas and Rajas, and I can testify to the eager loyalty with which the great Sirdars and the rest of the nobility and gentry placed all their means, men and money, and their personal services at the disposal of the Government instantly. There was happily an equal enthusiasm throughout British India on this occasion; but I may be forgiven for speaking of my own people of all ranks, hurrying to their depots, anxious to strike a blow for the Empire they have learned to look upon as partly their own. It was not as if the permanent Sikh army of 30,000 men had merely been willing to do their duty as soldiers of the King-Emperor. From villages, towns and great cities came out even retired and old Sikhs eager to fight the enemy of their "beloved Sarkar." The independent ruling States furnished munificent and spontaneous help in money and men, and their forces are fighting side by side with the splendid volunteers of our whole Empire in Flanders and France, Egypt, Mesopotamia, and East Africa—all the theatres of war. Once more the warriors of the Khalsa have proved themselves, in the words of Sir Lepel Griffin, "Equal to any troops in the world, and superior to any with whom they are likely to come in contact." Sir Ian Hamilton's great and generous praise of the quality shown by the 14th Sikh Regiment in the Dardanelles is fresh in your minds. So it will be, I do not hesitate to say, as long as the spirit of Guru Govind Singh animates the Khalsa, and the prophecy of the ninth Guru is fulfilled by the British Raj in India. As in the days of old, when their own cause was alone at stake, each and every Sikh will be at all times ready to leave the plough and take the sword in defence of what is now the common heritage of many peoples, and the glory of them all.

[The discussion on the paper will be published next week.]

HEMP SUPPLIES AVAILABLE.

An interesting and useful *résumé* regarding the sources of hemp supply at present available has been prepared by Professor L. H. Dewey, fibre expert to the United States Department of Agriculture. In this *résumé* Professor Dewey deals only with the true hemp, or soft fibre, such as is produced in Kentucky, and omits all reference to abaca, the so-called "manila hemp"—a hard fibre obtained from the leaf-stems of a banana-like plant in the Philippines; henequen—a hard fibre obtained from the leaves of an agave in Yucatan and Cuba; and true sisal—a hard fibre from the leaves of another agave in East Africa, the Bahamas, and Hawaii. Abaca, henequen and sisal are used

for binder twine, rope, cables and hawsers. Hemp is a fibre of very different character, not suitable for binder twine or for coarse cordage, and is used chiefly for "commercial" tying twines, carpet warps, and tarred cordage of small diameter. Being prepared and spun on different machinery and used for such different purposes, it competes only in a very indirect manner with the hard fibres.

The price of henequen has increased owing to political disturbances and a heavy export tax in Yucatan; the price of sisal has risen owing to the supplies from German East Africa and Java being practically cut off by the European war; and the price of abaca has advanced owing to typhoons in the Philippines and difficulties in ocean transportation, but the higher quotations for these hard fibres do not directly affect the price of hemp.

Professor Dewey points out that the true hemp plant, *Cannabis sativa*, is cultivated commercially for fibre production in Kentucky, Ohio, Indiana, Wisconsin, and California, and in China, Manchuria, Japan, Northern India, Turkey, Serbia, Rumania, Russia, Austria-Hungary, Italy, France, Belgium, Germany, Sweden and Chile. The principal countries producing hemp for export in recent years are Russia, Italy and Austria-Hungary. The supplies from these countries are now practically cut off, and the prices currently quoted for hemp fibre are abnormally high.

The importations of hemp into the United States in recent years have ranged from 5,000 to 8,000 tons annually, valued at £200,000 to £300,000 at the point of shipment. With these importations stopped and a reduced crop in Kentucky last year, the hemp-spinning mills—about twenty in number—in the United States are threatened with a hemp famine.

The estimated production of hemp fibre in the United States from the 1914 crop, of which at least one-fifth remains to be broken out, is as follows:—

State.	Area.	Average Yield per Acre.	Estimated Total Yield.
	Acres.	lb.	lb.
Kentucky . .	2,500	600	1,500,000
Ohio . . .	500	1,000	500,000
Indiana . . .	1,000	900	900,000
Wisconsin . .	350	1,000	350,000
Michigan . .	40	750	30,000
California . .	600	1,200	720,000
Total . .	4,990	802	4,000,000

The statement of acreage and estimated production does not include 1,500 acres in Indiana and Ohio sown with imported seed, producing a crop of such inferior quality that most of it was not harvested. The acreage in Kentucky was below the normal, and the severe drought in that State reduced the yield. There is some hemp, still unbroken, left over from the 1913 crop, but the total of all the fibre available until the crop of 1915 is ready for market is less than 2,500 tons, or about one-fourth of the normal supplies required by American spinners. Much of this is already sold or under contract.

Flax is the only other fibre of commerce similar to hemp in essential properties, but flax is even more difficult to secure than hemp at the present time. Indian jute, sunn, and chingma (China jute) may be substituted for hemp, but they are all weaker and very much less durable than that product. There are no satisfactory substitutes available.

An investigation has been made through the American Consular Service as to the supplies of hemp in China and other countries where it is produced but heretofore has not been exported to the United States. Chile, the only country in the Southern Hemisphere cultivating fibre hemp, does not produce enough for home consumption. It seems impossible to secure supplies from Serbia, Rumania, or from the Damascus region of Turkey. The spinning-mills in Japan consume practically all of the 10,000 tons of hemp and jute produced annually in that country and more than 15,000 tons additional imported from China and India. Excellent hemp is produced in Japan, the best and finest being that of the Tochigi district, while that of Hiroshima is more nearly like Kentucky hemp.

The production of hemp in China, the original home of the hemp plant, is probably greater than that of any other country except Russia, and the new Republic seems to offer the only promising sources of supply. Unfortunately the name "hemp," carelessly employed in the United States to indicate nearly all long fibres, is used in a similar manner by English-speaking people in China, and the Chinese name "ma" is used in the same unfortunate way. This confusion of terms causes some uncertainty, for the statements made in the reports submitted by Consuls include with hou-ma or Hsien-ma (hemp), ching-ma (China jute) in the north, huang-ma (India jute) and tung-ma (Sterculia fibre) in the south, and ch'u-ma or tsu-ma (ramie) in many localities. In ordering hemp from China, therefore, it is necessary to specify distinctly just what kind of fibre is desired.

The American Consul-General at Tientsin states that there is an abundance of fibres available for shipment from that port. The best is the hemp from the Kalgan district. The next best, from the Shun-te-fu district, is somewhat coarser. Ching-ma, known in the fibre markets of the United Kingdom as Tientsin jute, and ramie, from the Province of Hupei, are also sold in Tientsin.

The American Vice-Consul at Newchwang reports that two fibres, hemp (called Hsien-ma) and ching-ma, are exported from that port. The shipment of these fibres from Newchwang in 1914 amounted to 882,000 lb. This all went to other

parts of China, but with favourable market conditions some of it could probably be secured to meet a foreign demand.

The American Consul at Chungking, in the Province of Szechwan, reports that about 4,500,000 lb. of hou-ma (hemp) were shipped from that Province in 1914 to ports in the Yangtze Valley.

Samples of the fibres were received with the reports from the Consular officers, and were found to be all well cleaned, the hemp samples having excellent strength. The fibre is stiffer than dew-retted Kentucky hemp, and very different in appearance and feel from water-retted Italian hemp. The Kalgan, Shun-te-fu, and Hsien-ma samples, all true hemp, are very light coloured, suggesting some of the best grades of Russian or Californian hemp. The strands are in ribbons one thirty-second to one-fourth of an inch wide.

Ching-ma (China jute) is lustrous, yellow-white in colour, ribbon-like but fuzzy in texture, stronger than India jute, but more difficult to prepare for spinning because of its ribbon-like strands with fibres apparently interlacing towards the base. This fibre may be obtained in greatest abundance and at a relatively low price, but it is weaker and much less durable than hemp.

INTERNATIONAL INSTITUTE OF AGRICULTURE.

The June number of the *Bulletin of Agricultural and Commercial Statistics*, published by the International Institute of Agriculture, commences with information as to areas sown, condition of crops and yield in the Northern Hemisphere.

As regards the areas under cereal crops, amongst the chief new matter published in the present *Bulletin* may be noted the data from Spain (wheat 4,155,512 hectares, or 102·3 per cent. of the area in the preceding year and 107·6 per cent. of the five years' average 1909 to 1913, barley 1,414,454 hectares, or respectively 92·3 per cent. and 99·6 per cent.), from France (wheat 5,205,620 hectares, or 91 per cent. of the area of the preceding year and 80·4 per cent. of the five years' average 1909 to 1913, oats 3,044,760 hectares, or respectively 90·2 per cent. and 76·6 per cent.), from Canada (wheat 4,650,583 hectares, or 88·5 per cent. of the area in the preceding year and 109·5 per cent. of the five years' average 1909 to 1913, oats 4,249,140 hectares, or respectively 92·4 per cent. and 117·5 per cent.) and from the United States (spring wheat 7,224,121 hectares, or 91·8 per cent. of the area in the preceding year, and 95·3 per cent. of the five years' average 1909 to 1913, barley 3,139,180 hectares, or respectively 104·9 per cent. and 101·8 per cent., oats 16,430,009 hectares, or respectively 99·6 per cent. and 108·7 per cent.).

Some forecasts appear as to the wheat crop of 1916. In the United States the winter wheat crop is estimated at 127,611,469 quintals (71·6 per cent. of that of the preceding year, and 106·3 per cent. of the five years' average 1909 to 1913), and the spring wheat crop at 67,044,929 quintals (69·1 per cent. of that of the preceding year, and 100·4 per cent. of the five years' average). British India has reaped 86,546,883 quintals of wheat, or 82·9 per cent. of the yield of 1915 and 88·6 per cent. of the five years' average.

The forecast from Japan is for 6,653,000 quintals of wheat, or 94·8 per cent. of the crops of 1915, and 101·2 per cent. of the five years' average. That from Switzerland is for 1,172,000 quintals, with respective percentages of 108·8 per cent. and 129·9 per cent.

The United States estimate of the rye crop is for 11,091,093 quintals (88·8 per cent. and 125·1 per cent.), of the barley crop for 41,208,039 quintals (79·9 per cent. and 104·1 per cent.), and for 182,091,996 quintals of oats (81·4 per cent. and 110·9 per cent.). The Japanese forecast of barley is for 21,733,000 quintals (99·0 per cent. and 102·0 per cent.).

The crop conditions are generally satisfactory in France, Great Britain, Italy, Luxemburg, Sweden and Egypt, but less so in Hungary and Switzerland, while the season is said to be very late in Ireland, in the Netherlands and in Canada.

In the *Bulletin* information is added regarding crop conditions for flax, potatoes, sugar beet, tobacco, hops, hemp, rapeseed, cotton, vines and olive trees, and the development of the silkworm industry in the Northern Hemisphere, as well as the preparations in the Southern Hemisphere for the season of 1916–17.

The agricultural section of the *Bulletin* terminates with supplementary information on the yields of 1915 in Germany, Spain, Italy, and the United States, together with those of 1915–16 in Paraguay.

The commercial section of the *Bulletin* contains the usual tables of imports and exports, of stocks, and of prices for cereals and cotton in the principal markets. It also includes information on the current rates of ocean freight for cereals and cotton on the more important routes.

GENERAL NOTES.

GROWTH OF PETROLEUM-REFINING INDUSTRY.—The value of the annual production of the petroleum-refining industry of the country, according to the preliminary report by the United States Bureau of the Census, increased 67·2 per cent. between 1909 and 1914. The total cost of the crude petroleum increased 64 per cent. between those years. The production of naphthas and lighter products, chiefly gasoline, increased from 10,806,550 barrels in 1909 to 29,200,764 barrels in 1914, while the value increased from £8,286,000 to £25,400,000. The output of fuel oils increased from 34,034,577 barrels, valued at £7,596,000, to 74,669,821 barrels, valued at £17,504,000. Illuminating oils show an increase in quantity from 33,495,798 barrels, valued at £19,697,000, to

38,705,496 barrels, valued at £20,168,000, or an increase of 11·7 per cent. in quantity, and of 2·4 per cent. in value. On the other hand, lubricating oils show a decrease in quantity, with an increase in value, from 10,745,885 barrels, valued at £8,101,000, to 10,348,521 barrels, valued at £11,628,000. All other products, including residuum or tar, greases, paraffin, wax, asphalt, and subsidiary and by-products, increased in value from £5,694,000 to £7,876,000, or by 38·2 per cent. The gasoline product of the petroleum refineries does not include casing-head gasoline, condensed from natural gas at the gas wells. The total gasoline production, including casing-head gasoline, was 24,711,565 barrels of 50 gallons, or 1,235,578,250 gallons.

NICE AND THE FOOD SUPPLY OF SWITZERLAND.—Since the outbreak of the war considerable delay has been experienced in the discharge of ships, bringing foodstuffs for Switzerland, at Marseilles and Cette. To cope with the congestion problem, which was becoming serious, this traffic has been diverted to Nice, notwithstanding its 225 kilometres (140 English miles) greater distance by rail to the Swiss frontier at Bellegarde, 21 miles only from Geneva. Nice is 712 kilometres (442 miles) from the frontier station, as compared with 487 kilometres (302 miles) from Marseilles. It is anticipated that the cost of carriage by rail will be fully compensated by the reduction of demurrage charges. The port of Nice is well equipped with electric cranes and other appliances for discharging cargoes direct into the railway trucks without delay. There is ample quay space. The first vessel, the s.s. "Ness," bringing 4,400 tons of rice from Rangoon, arrived in this port a few days ago (May 7th), and several others are expected shortly.

TESTS FOR GUM ARABIC.—A study of many of the published tests for gum arabic, with descriptions of attempts to find others than the few that proved to be reliable, has been published by the United States Bureau of Standards. It was found that basic lead acetate gave the most characteristic reaction, while mixtures of copper sulphate and sodium hydroxide and of neutral ferric chloride and alcohol are of value as confirmatory tests. Dextrin and gum ghatti were subjected to the same tests. A summary of the more important methods that have been proposed for the quantitative estimation of gum arabic is next given, followed by a description of the steps that led the investigators at the Bureau to the use of alcoholic copper acetate-ammonia solution for this determination. Technologic Paper No. 67, "Some qualitative tests for gum arabic and its quantitative determination," may be obtained by interested persons from the United States Bureau of Standards, Washington, D.C.

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FRIDAY, JULY 28, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

EXAMINATIONS.

It has been found necessary to make a small increase in the Examination fees by adding 1*s*. for each subject in the Advanced Stage, and 6*d*. in the Intermediate and Elementary Stages.

The fees in future, therefore, will be as follows: Stage I., 2*s*. 6*d*. for one subject, and 1*s*. 6*d*. for each additional subject taken by the same candidate; Stage II., 3*s*.; and Stage III., 3*s*. 6*d*. for each subject.

The results of the Elementary (Stage I.) Examinations, held in April, were sent to the centres concerned on the 20th inst. This completes the issue of the results of the first division of the Examinations, those for the Advanced and Intermediate Stages having been sent out in June.

It is hoped to send out the results of the Advanced (Stage III.) Examinations, held in May and June, about the end of this month, and those of the Intermediate and Elementary Stages, held at the same time, during August.

The publication of the results is this year considerably delayed owing to the war, as not only is the Society's staff considerably depleted, but the Examiners have also lost the services of many assistants, who have joined H.M. Forces.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Friday, the 21st inst. Present:—

Sir William Duke, K.C.S.I., K.C.I.E. (Chairman of the Committee); Sir Charles Stuart Bayley, G.C.IE., K.C.S.I.; Thomas Jewell Bennett, C.I.E.; William Coldstream, B.A., I.C.S. (retired); Sir Frederic W. R. Fryer, K.C.S.I.; Sir Frederic S. P. Lely, K.C.I.E., C.S.I.; Sir John Ontario Miller, K.C.S.I.; Sir Frederick Alexander Robertson, LL.D.; Colonel Charles Edward Yate, C.S.I., C.M.G., M.P.; and S. Digby, C.I.E., Secretary of the Section.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

REPORT OF THE DISCUSSION ON THE PAPER ON

THE SIKHS.

By Sirdar Daljit Singh, C.S.I.,

Member of the Council of the Secretary of State for India.

(*Continued from p.* 631 *of the* Journal *of July 21st*, 1916.)

The Chairman (the Right Hon. Austen Chamberlain, M.P.) said the audience had had the opportunity of listening to an admirable paper on the history of a religion and a people which was full of interest for any thinking man. He was sure all had been struck by the nobility and beauty of the teaching of the founder of Sikhism, and had followed with interest the development of that teaching under his successors, and the gradual establishment of the great warlike race which was known at the present day. In the few observations he proposed to make he intended to dwell upon their services to the Empire in the war, because that was the subject which was uppermost in all minds, and it was well to remember the fine work done by the Sikh regiments. At the same time he did not wish it to be supposed that in speaking about the Sikhs he forgot the work done by other Indian soldiers of the King-Emperor. For the first time the Indian army had taken its place in a great European war by the side of armies coming from all the other Dominions of His Majesty. The Indian Army had served not only in France, but in Egypt, Gallipoli, East and West Africa, Aden and Mesopotamia. Wherever work had to be done and stout hearts were needed, India had sent her sons to play their part with the men from other portions of the Empire in the defence of their Sovereign's Crown, and of the liberties of the Empire to which they belonged. He was recently present at Buckingham Palace when His Majesty the King-Emperor received some Indian soldiers from one of the hospitals who desired to present an address to him. Among them was an officer who, since the war began, had fought at Aden,

on the Suez Canal, and in Gallipoli, and, after being invalided home suffering from illness, had gone to France and fought there; and, at the time he saw him, was on the point of leaving for India. He asked the officer if he had any wish, and he replied that he desired not to be sent home to India but to Mesopotamia, so that then he would have fought in all the theatres of war. That spirit was characteristic of the army to which he belonged. In the many theatres in which they had been engaged they had reaped a full share of the honours that were earned. He found that among the ranks of the Indian army over 1,300 decorations had been conferred for services in the war, of which nearly 400 had been won by Sikhs. Among the decorations Victoria Crosses had been won by seven of various ranks, one of the recipients being a Sikh; the Military Cross by twenty-six, of whom six were Sikhs; the Indian Order of Merit of the First Class by six, of whom two were Sikhs; and the Indian Order of Merit of the Second Class by 416, of whom 119 were Sikhs. He asked the audience to bear with him for a few moments while he narrated two instances which gave some idea of the services by which such distinctions had been earned. The first case was that of the 14th King George's Own Sikhs in Gallipoli, as told to him by Major-General Sir Henry Cox, who commanded the 29th Indian Brigade at the time. The 14th Sikhs went into action on the left flank of the famous 29th Division, and attacked and carried the Turkish trenches in front of them. There were fourteen British officers, eighteen Indian officers, and about 500 of Indian ranks when they started. Unsupported they held on to the ground they had taken for twenty-four hours, and when they were withdrawn they came out with only two British officers, five Indian officers and about 120 of the Indian ranks. The ground was retaken a few days later, and everywhere a Sikh was found on the top of a Turk, and not a man's face was looking the wrong way. The second incident, part of the story connected with which had already been published, occurred in France, and was as follows: On the night of May 17th a company of the 15th Sikhs under Captain K. Hyde-Cates, relieved a portion of the 1st Battalion Highland Light Infantry in a section of a trench known as the "Glory Hole" near the *Ferme du Bois* on the right of the Indian Army Corps front. Furious fighting had been in progress there for some time, the position at the moment of relief being that we had taken and occupied a section of the German trench, a portion of the same trench on our left being still held by the enemy, who had succeeded in erecting a barricade between themselves and our men. In the early morning Captain Cates observed that attempts were being made to reinforce the enemy in the trench. Numbers of Germans were seen rushing towards the further extremity of the enemy's trench. Rapid fire was brought to bear on them as they crossed the open, but in the dim light the effect could not be judged. When day broke it was ascertained that the German trench was packed with men, with the evident intention of attacking us. A short time afterwards the attack began by heavy bombarding, to which the 15th replied vigorously and succeeded in holding their own until noon, when the position became critical, as all our dry bombs had been expended and those that had become wet from rain were found to be useless. It was then resolved to attempt to relieve the situation by sending up a bombing party from the reserve trenches. The desperate nature of this undertaking may be gauged from the fact that two previous attempts had been made by the Highland Light Infantry. On both occasions they failed; the officers in command being killed and the parties having suffered very severely. However, the position was desperate, and Lieutenant Smyth, a young officer who, in spite of his years—he was only twenty-one—had already been brought to notice for his gallantry, was ordered to take command of the party. Volunteers were called for and were immediately forthcoming. The alacrity with which the demand was responded to spoke volumes for the spirit of the regiment, for each man felt sure that he was proceeding to almost certain death. Lieutenant Smyth and his little party of ten men started at 2 p.m. to cover the 250 yards which intervened between them and our trench, taking with them two boxes of ninety-six bombs. The ground to be covered was absolutely open, devoid of all natural cover. The only possible shelter from the frightful fire which met the party as soon as they were over our parapet was an old broken-down trench which, at the best of times, was hardly knee-deep, but now, in places, was filled almost to the top with the dead bodies of Highland Light Infantry, Worcesters, Indians, and Germans. Truly it was an undertaking to appal the stoutest heart. Dropping over our parapet, they wriggled their way through the mud, pulling and pushing the boxes with them, until they reached the scanty shelter of the old trench, where they commenced a progress which, for sheer horrors, can seldom have been surpassed. Pagris had been attached to the front of the boxes. By means of these the men in front pulled the boxes along over and through the dead bodies, while those in the rear pushed with all their might, the whole party lying flat. At any minute the bombs might have exploded. The whole ground was hissing with the deluge of rifle and machine-gun fire, while the air above them was white with the puffs of shrapnel. To the anxious watchers in the rear it seemed impossible that a single man should win through. After they had accomplished a mere twenty yards of their deadly journey, Sepoy Fatteh

Singh rolled over wounded, followed in the next eighty yards by three sepoys—Sucha Singh, Ujagar Singh, and Sunder Singh. This left only Lieutenant Smyth and six men to get the two boxes along. Under ordinary circumstances four men are required to handle a box of bombs. They crawled on and on until, just before they reached the end of the trench, the party had dwindled to two—Lieutenant Smyth and Sepoy Lal Singh. Of the remainder of the band of heroes, Sepoys Sarain Singh and Sapooram Singh had been killed, Ganda Singh, Harnam Singh, and Naik Mangal Singh being wounded. The second box of bombs had, therefore, to be abandoned, and to haul even one box along in the face of such difficulties appeared an impossible task. Still pulling and hauling, Lieutenant Smyth and Lal Singh emerged, wriggling painfully along into the open, where they were met with an increased blast of fire. Miraculously surviving this, they crawled on only to be confronted suddenly by a small stream which was too deep to wade. Across it lay the direct line to safety. The ordinary man, under such circumstances, would probably have taken it, but these were no ordinary men. They crawled on and on, in full view of an enemy now at close quarters, until they came to a point in the stream which was just fordable. Across this they struggled with their valuable burden, and in a few yards they were amongst their friends in our trench, both untouched, although their clothes were perforated with bullet holes. Sad to relate shortly after reaching the trench the gallant Sepoy Lal Singh was killed. For his most conspicuous bravery Lieutenant Smyth has now been awarded the Victoria Cross and each of the brave men with him the Indian Distinguished Service Medal. He offered no apology for the time he had occupied in reading the account of the two instances he had quoted—two only, out of many —which showed how Sikh soldiers had fought. He was sure those present would join with him in expressing their admiration for such deeds, and for the men who performed them.

Sir Louis W. Dane, G.C.I.E., C.S.I., said that nearly the whole of his service in India was passed in Sikh districts, and he had had the honour of being Lieutenant-Governor of the Sikh Province of the Punjab. Whatever success he had achieved in life was due to the Sikhs, and the least he could do was to offer his poor tribute to their magnificent history as adherents of a creed, as a nation, and as men. Mr. Chamberlain had said something of what the rank and file of the Sikh regiments had done in the present war, and the author had referred to what they had done in previous wars. He desired to point out the conspicuous service the Sikh chiefs, as distinct from the rank and file, had rendered to this country in a time of most signal difficulty. The map of the Punjab showed that the line of communications between Umballa and Delhi was practically entirely through the territories of the great Sikh chiefs, and if those chiefs had not stood by this country during the Mutiny he had very little hesitation in saying that it would have been absolutely impossible for the British troops to have retained their position upon the ridge and to have taken Delhi. Some people did not quite appreciate the difference between Sikhs and Singhs. They saw them with shaved beards, and asked how such persons could be Sikhs. Their idea of a Sikh was a tall, stately man with all his hair and a very fine martial carriage. The fact of the matter was that until a Sikh had taken the *pahul* he did not become a Singh. It was not obligatory upon him to let all his hair grow. Although he had very many good friends among Sikhs who had not taken the *pahul* and who shaved, it was his experience that those who had taken the *pahul*, or Kesdhari Sikhs, were more successful in their careers than the Sahjdhari Sikhs, who cut their hair. He did not know why that should be so, unless it was that, like Samson, the virtue resided in their hair, or because the precepts of their religion prevented them from smoking. In the central Punjab it was frequently found that in the same village, or in adjacent villages, there were men of the same stock, some of whom were Mohammedans, some of whom were Hindus or Sikhs, who shaved, and some of whom were Singhs who did not cut their hair at all. Of those three classes it was invariably the case that the section which was most prosperous and successful was the Singh section. They made a good deal of money by serving in the Army and under the Government in various offices, but that of itself was not sufficient to explain the circumstance. He left it to the ethnologist to decide why it was that men descended from the same common ancestors under exactly similar economic conditions showed such varied results in practice. The Mohammedans often said that the reason they did not succeed was because they smoked too much. They said they could not get up in the morning and go on with the ploughing until they had spent half an hour at the hookah; and every hour or hour and a half during the day they did the same. He did not wish to say anything against smokers, but he was inclined to think there was a good deal in the suggestion. On the other hand, while the Singhs did not smoke, they took a little spirit occasionally. All Singhs over thirty or forty years of age usually took a decoction of poppy seeds in water, or even a small pill of opium, but it did not seem to do them any particular harm. The result remained that the Singhs were invariably successful agriculturists and exceedingly prosperous. It was much to be regretted that the Sikhs had to leave the Punjab because, like the Irish, good careers were not open to them in their own country. When they went abroad they sometimes imbibed modern

ideas which were not thoroughly well digested, and a good deal of trouble had arisen from that fact in the past. He believed the remedy for that state of affairs was to endeavour to provide for the non-agriculturist class of Sikhs, to whom the wayfarers largely belonged, a good career in their own country. Anything that could be done in the way of introducing more capital into the Punjab for the greater development of the arts and industries in that Province, whereby the Sikh workmen would be able to remain at home and earn a good living, would be a great thing for the nation of the Sikhs and also for the British Empire.

General Sir O'Moore Creagh, V.C., G.C.B., G.C.S.I., said that this was an unique occasion because they had heard for the first time in London a paper by a highly-educated Indian nobleman whose education had been based on Oriental tradition. Such a basis of education alone enabled Indians to keep their position among their people and the chiefs, and also to be leaders among them. That was not the case with those people whose English education was based on ideas generated in the West. The views obtained by the latter were often apt to be ill-digested and unorthodox, and for that reason were not popular among Indians generally. He believed that if it was desired to obtain the views of Indians they must be forthcoming from the chiefs, nobles and gentry, who were the real leaders of the people and had a great stake in their country. None of the gallant deeds which had been narrated, performed by Sikhs in the present war, had been heard by him with astonishment, because he had spent forty-five years of his life in peace and war among the Sikhs and knew the loyalty and gallantry of this brave people. The Sirdar had mentioned a very remarkable fact, that, in spite of the two wars that took place between the Sikhs and the British, only eleven years afterwards they assisted the British Government against the mutineers in India. The conclusion he had come to was that the Sikhs assisted the Government in the Mutiny because of the friendships which existed between the first British officers who were sent to rule the Punjab and the chiefs, gentry and priesthood. Through a long course of history, friendships in the East had exercised a great and most important influence, and he could not too strongly emphasise the immense importance, as well as the pleasure it was to themselves, of all British officers who served in India making friends with the nobility, gentry and priesthood of the country. He specially mentioned the priesthood, because in a country like India, unless one knew the thoughts and aspirations of the priesthood, very little could be done in leading the people towards modern methods of civilisation. He had known Sikh soldiers from his earliest days, and was thoroughly acquainted with the friendly relations that had always existed between the family of Sirdar Daljit Singh and British officers. The Sirdar's lamented brother did everything he possibly could to alleviate the somewhat dull conditions of the British soldiers in the Punjab. Just before his death he endeavoured, with the aid of the Sikh Chiefs' Association in the Punjab, to get the great landowners and noblemen to open some of their forests for the soldiers to shoot, fish and sport in. That was a most noble idea, because it benefited the British soldier's health and trained him for war; a good sportsman was always a good soldier. He held his own ideas on the subject referred to by Sir Louis Dane of the Sikhs who cut their hair and those who did not. Those who cut their hair were not attentive to their religion, while the others were. Only such as did not cut their hair were enlisted in the army. Unless a soldier or a cultivator, or any other class of man, was attentive to his religion he was no good. Many troubles were caused by want of knowledge of the religions of India.

General Sir Edmund Barrow, G.C.B., said that twenty years ago English people imagined that there were no soldiers in the Indian army other than Sikhs—a fact which was very much to the credit of the Sikhs, because they were such fine soldiers that every Indian who was worth anything was always dubbed a Sikh. The Sikh population of India was only $2\frac{1}{2}$ million, or $\frac{1}{126}$ of the total population; nevertheless, they contributed one-fifth of the whole of the men in the Indian army. That alone was a sufficient tribute to the value of the Sikh element to the British Empire.

Sir Frederick A. Robertson, LL.D., said that, having spent thirty-five years in the Punjab and marched through every Sikh district in that Province, and having also an enormous number of friends amongst all classes of Sikhs, he could speak with some outside knowledge of the subject as compared with the inside knowledge possessed by the author. Coming in contact with them as an administrative officer, he saw the best side of them. It was afterwards his fortune to serve in India in a different capacity, and he then saw something of the other side. Speaking as an intimate friend of Sikhs, he thought it was as well to give a word of warning about one or two dangers the Sikh seemed to him to be running. The first was that he sometimes had a little too much to drink; and there was a danger of that becoming too common a habit. The drink came largely from the same source as some of the drink produced in Ireland: it was not made in any Government still. When the Sikh indulged in that little amusement he became a very dangerous creature. The other danger

was a curious result of legislation which had been passed. The ordinary moneylender had been prevented in the Punjab from acquiring land; only men of the agricultural classes could buy land. As a result, the Sikh, who was essentially an agriculturist and a very careful person, was in some danger of getting the reputation of being a land-grabber, because the position of moneylender was occupied by Sikhs who were ready to buy up the land of other agriculturists. Dealing with the various characteristics of the Sikhs, the first thing that struck anyone in marching through a Sikh district and seeing their agricultural methods was their extraordinary patience and attention to work. The Punjab had a doubtful climate, and the difficulties connected with agriculture were great; but he had never known a Sikh fail to face those difficulties with the greatest courage and determination, and he generally overcame them. He was absolutely the ideal agriculturist. He remembered that at a big Highland dinner at Lahore, the late Sir George White made a speech in which he compared the characteristics of the Sikh to those of the Highlanders of Scotland. He did not think that parallel was altogether a good one. Personally he would be more inclined to compare the Sikh to the Lowland Scot. He had the same determination, the same power of looking after his money, and the same power of facing good and bad fortune, which the Lowland Scot possessed. In one important respect the Sikhs resembled the Highlanders—and it had been of the greatest value to the Empire—namely, that when the fight was over they were the best of friends. No two nations every fought each other more strenuously than the English and the Scotch and the British and the Sikhs, and now they were the very best of friends.

Sir George Birdwood, K.C.I.E., C.S.I., in moving a vote of thanks to Sirdar Daljit Singh, said he had the greatest pleasure in so doing; and not only because he was deeply interested in the subject of it, through the fact of the translator into English of the *Grantha* [*i.e.* Sacred "Book"] of the Sikhs, Ernest Trumpp, having been a great friend of his father, and done much of the translation of "the Book" in his father's house, both in Karrachee and at Aden, but also because of the excellence of the paper, and of the high esteem in which the author of it was held by everyone who had known him in India. He would only ask the Sirdar Sahib, in view of the phenomenal ignorance of the "stay-at-home" English, in revising his paper for publication, to add, either as a footnote or immediately after the first paragraph, a chronological table of the succession of "the Ten-Gurus" [literally, "Weighty"-men, *i.e.* Priests] of the Sikhs, adding the two supernumerary ones included in the list by some; and, if after every Indian word unfamiliar to the "stay-at-home" English, the Sirdar Sahib would give its radical and derivative meanings, it would add greatly to their intelligent assimilation of the invaluable information and wisdom treasured up in the paper. For two or three instances: Sikh was from *sikna*, "to learn," through *sishya* a "student," and hence a "Disciple"; Khalsa meant "pure," "select," "elect," and hence "the Sikh Theocracy", *sharbat* meant literally "a draught," and in the *pahul*, or rite of initiation of the Nanak-Shahi, or Sikhs, it was a mixture of sugar and water, and therefore the name of *Amrita* [*i.e.* "Deathless"], although as a word equivalent to the Greek word "Ambrosia," the mixture it denoted was a "Nectar" ["Better"-drink?] and not an Ambrosia, or "food of the gods"; and so on with a dozen other cryptic words. The designation "Muhammadan" [from Muhammad, "the Praised," "the Prophet of God"], in classical English "Mahomet," was most offensive to Muslims [*i.e.* "Believers"]; indeed, was regarded by them as blasphemous and should never be used of them. But the great lesson to be learned from the history of the Sikhs was that their success as a secular power was based on the force of their spiritual convictions and enthusiasm, exactly as in the case of the Saracen Muslims; and that the secret of their decay, as of that of the Saracens, lay in the fact of their having admitted "Believers" of the inferior races of mankind to a social as well as spiritual equality with themselves. This was a natural enough, almost an unavoidable error, and committed long before then by the primeval Aryan invaders of India, and again later by the Spaniards in America; the evil of it in both these cases having been aggravated by the depressing effect of the heat of all countries lying within the north and south tropical zone. This double danger was the greatest menace of the future to the United States of America, where both the mulattos and the creoles were increasing in numbers. It should never be forgotten that it was not the Rome of the ancient Romans that was overthrown by the virile barbarians, but the Rome of African and Syrian Roman mulattos and creoles.

Mr. Mirza Abbas Ali Baig, C.S.I., in seconding the motion, said that the Chairman's stirring and appreciative words would convey a cheering and inspiring message to all Indian soldiers, who were now fighting the battles of the Empire on three continents, as well as to the people of India.

The resolution was carried unanimously, and briefly acknowledged by Sirdar Daljit Singh.

Sir Krishna Gupta, K.C.S.I., in thanking the Chairman, on behalf of the Society, for presiding, said Mr. Chamberlain had done a

great service to India by recalling the gallant deeds the men of the Indian army had performed in many theatres of the present worldwide war. There was some risk of those services being overlooked and forgotten in view of the clamorous demands made in the same direction by the younger daughters of the Empire, and, as an Indian, he was, therefore, most grateful to Mr. Chamberlain for bringing the services of the Indian army so prominently to the notice of the British public.

THE HISTORY OF THE SAFETY-LAMP.*

The earliest references to the nature of firedamp appear to occur in the latter part of the seventeenth century. From these it is evident that the risk of its ignition and explosion was known, and it was recognised that ventilation (to keep the air very "quick") was a means of prevention of these dangers. The recognition of the presence of firedamp by means of the candle-flame was also known. No remedy other than ventilation appears to have been suggested until about 1730 or 1750, when the flint-and-steel mill was invented. This invention is attributed to Mr. Carlisle Spedding, of Whitehaven. The use of flint and steel in the presence of firedamp is mentioned by Sir James Lowther in 1733, and Mr. John Buddle in 1813 gave a full description of the flint-and-steel mill. This instrument, however, did not give immunity from explosion. An explosion at Wallsend in 1785 was stated by Mr. Buddle to have been traced to the use of the steel mill, and he also affirmed that, although he had never witnessed an explosion from the sparks emitted by the instrument, yet "the inflammable air has frequently fired at the sparks of the steel mills, but only when they are played near the place where the hydrogen gas is discharged." Matthias Dunn also asserted that explosions were originated by the flint-and-steel mill. Other attempts to avoid the use of naked lights in presence of firedamp were made, and Von Humboldt describes a lamp invented by him in which the flame was supplied with air from an air-reservoir. The use of phosphoric lights, fish in a state of incipient putrescence, Amadou (or fungus tinder), and other schemes were suggested, whilst sunlight was directed down the shaft by mirrors, and proposals were made at a later date to reflect the light into the workings.

Some progress was also made in respect of the knowledge of the properties and composition of firedamp. Some investigators recognised its similarity to hydrogen gas, and were aware that it was heavier than hydrogen, but lighter than air; and although Volta pointed out the differences between firedamp and hydrogen as early as 1776, and Berthollet proved that it contained both carbon and hydrogen in its composition, still firedamp continued to be spoken of as "hydrogen." In 1805 Dr. William Henry distinguished between marsh-gas and olefiant gas. The occurrence of firedamp in coal-mines was, however, not understood at this date, and in many instances its presence was attributed to the decomposition of water by iron pyrites, or to the decomposition of water by the coal with separation of the hydrogen.

The years 1812 and 1813 were important in the history of the safety-lamp. On May 25th, 1812, an explosion occurred at the Felling Colliery. In consequence of this explosion, the Rev. John Hodgson, the incumbent of Jarrow and Heworth, and Mr. James John Wilkinson took steps which eventually resulted in the formation on October 1st, 1813, of the "Society in Sunderland for Preventing Accidents in Coal Mines." This Society had, as Patron, His Grace the Duke of Northumberland; there were sixteen Vice-Presidents, with Sir Ralph Milbanke, Bt., as President, and Mr. W. Burn as Secretary. In addition, there was a permanent committee of twenty-eight, among whom were the Rev. Robert Gray, the Rev. John Hodgson, William Reid Clanny, James John Wilkinson, John Buddle, and Matthias Dunn. This Society was most assiduous in its endeavours to promote the objects for which it was formed, and it was due to its efforts that the safety-lamp was introduced at this period. Among those who, at the time when the Society was formed, were actively engaged in endeavouring to discover some safe means of lighting coal-mines were William Reid Clanny and George Stephenson, and the Society, apparently influenced by Mr. Buddle's expressed opinion that nothing further could be done to prevent explosion by the application of mechanical agencies, that the only remedy lay in the discovery of some chemical method for rendering firedamp harmless as it was discharged, and that it had to look to scientific men for assistance in providing "a cheap and effectual remedy," eventually determined to apply to Sir Humphry Davy for assistance.

The work accomplished by the Society in connection with the movement of the safety-lamp entitles it to be gratefully remembered by all interested in coal-mining.

Dr. Clanny.—William Reid Clanny was born in 1776 at Bangor, County Down, Ireland. He entered the medical profession, and eventually settled down in practice at Bishop Wearmouth, near Sunderland. In 1810 his attention was drawn to the subject of explosion of firedamp in collieries. He invented a number of lamps, among which is the well-known Clanny lamp. On May 23rd, 1813, he contributed a paper on his newly-invented lamp to the Royal Society.

Clanny's first lamp (the "Blast" lamp) consisted of a lantern with cisterns of water above and

* Abstract of a paper on "The History of the Safety-Lamp," by Professor F. W. Hardwick, M.A., and Professor L. T. O'Shea, M.Sc., read at the meeting of the Institution of Mining Engineers, held in the Rooms of the Geological Society, Burlington House, on Thursday, June 8th. Published by permission of the Institution.

below the light. Air was forced in by means of a bellows, so that it bubbled through the water in the lower cistern whilst the products of combustion escaped through a chimney at the top, the open end of which was narrowed and bent over so as to dip beneath the surface of the water in the upper cistern. This lamp was tested on the surface on October 16th, 1815, and underground on November 20th, 1815. The construction of the lamp was subsequently modified: the water cisterns were abandoned, the oil in the oil-vessel was used to seal the inlet of the air, and the outlet consisted of a vertical chimney that tapered to a fine point.

His second lamp was exhibited to the Sunderland Society in December, 1816, was described before the Royal Society of Arts on April 2nd, 1817, and was known as the "Steam" lamp.* Air passed in through a tube in the bottom of the lamp, and was conducted through an extension of the tube to a point high up in the lamp. Above the oil-vessel and flame, and situated about the middle of the lamp, was a water reservoir. The water in the reservoir was boiled by the heat from the oil-flame. The air was conducted below the oil-vessel by two tubes, and then passed up the sides of the cistern, where it mixed with steam from the boiling water and finally escaped through the chimney.

A third lamp was the "Gaslight" lamp, which was stated to have been designed to burn firedamp in lieu of oil in an atmosphere charged with gas. It was similar in construction to the Steam lamp.

These early examples of Clanny's lamps show the important part that Clanny took in his attempt to reduce the dangers arising from the use of naked lights, and in 1843 the South Shields Committee for Investigating the Causes of Accidents in Coal Mines expressed their opinion of the value of his labours as follows:—

"Dr. Clanny, in this country, appears to have been the first man of science that conceived it possible to enter into a contest with this destructive element [firedamp], and, sustained by his unwearied philanthropy, has never ceased for thirty years to devote his talents and exertions to mitigate the horrors consequent upon its explosion. A life so spent, it is to be hoped, will not be allowed to pass without some mark of respect from his country, or of gratitude from those he has laboured so much to benefit."

George Stephenson.—George Stephenson, born on June 9th, 1781, at Wylam, near Newcastle-upon-Tyne, was, at the age of fourteen, appointed assistant fireman at Dewley Burn Colliery, and enginewright at Killingworth Colliery in 1812.

The idea of his first lamp ("The Tube and Slider" lamp) was conceived from experiments made on blowers that he met with in the Killingworth Pit. He found that the "burnt air" from five or six candles held to windward of an ignited blower would extinguish the flame. Further, that when firedamp was ignited, an appreciable time was necessary for the flame to travel from one point to another, and his idea was that if the upper part of a lamp could be charged with burnt air, whilst the firedamp was admitted below in small quantity and burnt as it came in, then the burnt air would prevent the explosion from travelling upwards, and the velocity of the entering current would prevent it from passing downwards. In the "Tube and Slider" lamp air was admitted through a tube ½ inch in diameter, and passed from the centre of the bottom of the lamp to the centre of the wick; the bottom of the tube could be wholly or partly closed by a valve or shutter, and so the admission of air regulated. This lamp was tested on October 1st, 1815, at Killingworth Colliery. Subsequently Stephenson undertook some experiments on firedamp and tubes which decided him to substitute three tubes for the single air-inlet tube, and he constructed his second, or "Tube" lamp, in which the air was admitted through three tubes, 3½ inches long and $\frac{3}{32}$ inch in diameter; the air passed from the bottom of the lamp through the oil-vessel, the upper ends of the tubes being inclined towards the wick. This lamp was tried at Killingworth Colliery on November 4th, 1815. Subsequently Stephenson decided that to admit air into the lamp through capillary tubes would be a better method, but afterwards he decided to adopt smaller holes drilled in a plate, and constructed his third lamp, into which air was admitted through holes in the side of the oil-vessel, then through small holes from $\frac{3}{28}$ to $\frac{1}{32}$ inch in diameter into a space between two plates, whence the air issued to the flame through a set of holes $\frac{1}{12}$ to $\frac{1}{13}$ inch in diameter punched in a metal ring. This lamp was tried underground on November 30th, 1815. In the final form of Stephenson's lamp, the punched plate was replaced by a gauze cylinder, which surrounded the glass cylinder; air was admitted through small holes in the ring to which the standards are fixed or in a flange just above the ring. It has not been possible to ascertain the date when the wire gauze was substituted for the punched plate.

Sir Humphry Davy.—Sir Humphry Davy was born near Penzance on December 17th, 1778. He was educated at the Penzance Grammar School, and was eventually apprenticed to Mr. J. B. Borlase, a surgeon and apothecary. He devoted his attention chiefly to chemistry, and in 1798 was appointed Superintendent in the laboratory of the Pneumatic Institute at Bristol, where he investigated the properties of various gases, among them carburetted hydrogen. In 1801 he joined the Royal Institution

* Dr. Clanny brought two forms of his lamp before the Society; for the one above described he received a silver medal in 1816, and for the second (the Steam lamp) a gold medal in 1817. By an unfortunate error the dates are wrongly given in the "History of the Society," p. 254, as 1815 and 1816. Further information about Clanny's lamps will be found in the full text of the paper when it is published. Professor Hardwick has kindly furnished the Secretary with some notes and has thereby enabled him to add the references contained in the footnotes on this and subsequent pages.—H. T. W.

as Assistant Lecturer in Chemistry, Director of the Laboratory, and Assistant Editor of the Journals of the Institution, and on May 31st, 1802, was appointed Professor. He was elected a Fellow of the Royal Society in 1803, was Secretary of that Society from 1807 to 1812, and was elected President on November 30th, 1820. He was knighted in 1812 and created a Baronet in 1818. On resigning his Professorship at the Royal Institution, he was elected Honorary Professor of Chemistry. He died at Geneva on May 29th, 1829.

It was in August, 1815, that Davy met the Sunderland Committee, and after learning the conditions under which coal was mined and paying visits to the Hebburn and Wallsend collieries, he returned to London and commenced his investigations into the nature of firedamp, which eventually led to the invention of his lamp. On November 9th, 1815, he read a paper before the Royal Society "On the Fire Damp of Coal Mines and on Methods of Lighting the Mines so as to prevent Explosion." In this he gave an account of his investigations into the explosive properties of firedamp and the passage of flames through glass and metallic tubes. In his paper he stated :—

"It is evident that to prevent explosions in mines it is only necessary to use air-tight lanterns, supplied with air from tubes or canals of small diameter, or from apertures covered with wire gauze placed below the flame, through which explosions cannot be communicated, and having a chimney at the upper part on a similar system to carry off the foul air; and common lanterns may be easily adapted to the purpose, by being made air-tight in the door and sides, by being furnished with the chimney, and the system of safety apertures below and above."

In the paper three lamps are described: they appear to have been lanterns of tin plate with four glass plates in the side. In the first lamp air entered below the flame through a number of tubes $\frac{1}{8}$ inch in diameter and $1\frac{1}{2}$ inches long, and the products of combustion escaped through a chimney composed of two open cones protected by a plate containing many small apertures. In the second lamp both inlet and outlet were protected by "safety canals" consisting of concentric metallic cylinders, one within the other, and separated from one another by annular spaces from $\frac{1}{24}$ to $\frac{1}{40}$ inch wide and $1\frac{7}{10}$ inches long. The inlet and outlet of the third lamp were protected by brass-wire gauze $\frac{1}{200}$ inch thick having apertures not more than $\frac{1}{120}$ inch. A little more than a month later, namely on January 1st, 1816, Davy announced to Dr. Gray his important discovery of the use of the gauze cylinder, and communicated his discovery to the Royal Society in a paper on January 11th, 1816. In this paper he describes his invention as follows :—

"This invention consists in covering or surrounding the flame of a lamp or candle by a wire sieve; the coarsest that I have tried with perfect safety contained 625 apertures in a square inch and the wire was $\frac{1}{70}$ of an inch in thickness, the finest 6,400 apertures in a square inch and the wire was $\frac{1}{250}$ of an inch in thickness."

The first Davy lamps seem to have been tried at Hebburn Colliery on January the 9th and 17th, 1816. Davy recommended the use of iron-wire gauze composed of wire from $\frac{1}{40}$ to $\frac{1}{60}$ of an inch in diameter and uncovered with any easily combustible metal; that in proportion as the inflammability of the gas increases the apertures should be smaller and the radiating surface greater; and that several gauzes superposed might be necessary for continuous explosive mixtures. He pointed out that no aperture should be allowed in the lamp and the precaution of supplying a short gauze cap over the top of the main gauze cylinder. He also gave dimensions for the cubic contents of the lamp, recommending that the lamp should be from 8 to 10 inches high, and from 2 to $2\frac{1}{2}$ inches in diameter. Davy appeared to be aware of the limitations to the safety of his lamp, especially in currents of explosive gas, and recommended the use of twilled gauze or the protection of the gauze by a glass cylinder above the flame or a tin screen outside the gauze. On September 6th, 1816, he visited Wallsend Colliery and performed experiments with his lamps, and in pointing out the lessons to be learnt, said :—

"Now, gentlemen, you see the nature of the danger to which you are exposed in using the lamp, and I caution you to guard against it in the manner I have shown you. This is to show the only case in which the lamp will explode, and I caution you and warn you not to use it in any such case when you can avoid it, without using the shield."

There is little doubt that Clanny considered himself the inventor of the first safe lamp, and a regrettable controversy arose towards the end of 1816 as to whether Stephenson or Davy was to be regarded as the first inventor of the safety-lamp. It is not necessary to go into the details of the controversy, but in regard to the merits of these two inventors Stephenson deserves great credit for his work. Unacquainted with the principles of chemistry, and devoid of proper apparatus for experimentation, he was yet able to produce a lamp which seems to have been safe under the conditions for which it was designed. But to Davy's work the mining community is indebted for the safety-lamp as it exists to-day; not only did he invent a lamp which was within limits safe, but he laid down the principles of safety which have been followed and confirmed by subsequent investigators.

About the same time lamps were devised by Chèvremont; John Murray, Lecturer on Chemistry at Hull; Dr. John Murray; and R. W. Brandling. All these were similar, and consisted of enclosed lamps connected with long tubes through which air free from firedamp could be brought from a distance.

Period 1816 to 1835.—The Davy and Stephenson

lamps came into use shortly after their invention, and in 1818 the Davy was used in the North of England, Whitehaven, and Wales. It was also introduced into France, Belgium, and Germany. It was during this period that distrust arose as to the safety of the Davy lamp when exposed to currents of explosive mixtures other than those moving with low velocities. Davy had foreseen the danger, and had suggested precautions that should be taken. There appears to have been a feeling of disappointment that since the introduction of the safety-lamps mortality due to accidents from firedamp had increased. In 1835 a Select Committee on Accidents in Mines was appointed. The Committee issued its report on September 4th of the same year, in which they stated that "ignorance and a false reliance" on the merits of the Davy safety-lamps "in cases attended with unwarranted risks have led to disastrous consequences"; but a more extended use of the safety-lamp was recommended —"in some mines, now lighted by the ordinary means, the use of the lamp ought to be compelled by the owners." Among the lamps brought to the notice of the Committee that of Upton & Roberts* is commended. This lamp consisted of a gauze chimney of the Davy type enclosed in a glass cylinder; above the glass and fitting closely on to it was a metal chimney with perforated top. The air entered the lamp through horizontal holes just above the oil-vessel, and passed through a double layer of gauze into a cone, by which it was directed on to the flame.

During this period Clanny brought out his fourth or "New" lamp. It was a Davy lamp fitted with a telescopic extinguisher in three sections. When pushed up, it was held in its place by a thin brass wire and exposed two-thirds of the gauze cylinder. In an inflammable atmosphere the wire fused and let down the shield, leaving only a small scrap of gauze exposed. The flame of the burning gas was extinguished, but a small oil-flame continued to burn. Other lamps introduced during this period were a Mueseler lamp similar to the Upton & Roberts, lamps by John Martin, John Newman, John Dillon, and the "Refrigerating" lamp of Wood, all of which are briefly described in the paper.

Period 1836 to 1843.—During this period two important investigations into safety-lamps were carried out, namely:—

(1) By the Belgian Commission, appointed on April 13th, 1836; and

(2) By the South Shields Committee, appointed shortly after the explosion at St. Hilda Colliery, which occurred on June 28th, 1839.

* In 1826 a silver medal was awarded by the Society of Arts to J. Roberts for a safety lamp, and in 1830 a second silver medal to J. Roberts (the addresses are different) for a reflector for safety lamps. Mr. Hardwick considers it certain that the recipient of the first medal was identical with John Roberts, Upton's partner, but does not think that the lamp rewarded was the same as the one mentioned in the text. This, he believes, could not have been invented before 1831, though the date is often given as 1827.—H. T. W.

Both Committees tested safety-lamps from the point of view of safety, and issued reports.

The Belgian Commission issued three reports: the first on April 25th, 1840, the second on August 31st, 1840, and the third on August 30th, 1841.

Among the lamps brought before the Commission and tested were the Davy, two lamps designed by Mueseler, the Cambrésy, the Dumesnil, and the Upton & Roberts. In the first report the opinion was expressed that the Davy lamp left much to be desired as regards safety, but that no lamp had been found to take its place except the Dumesnil. In the second report the Commission recommended that the Dumesnil, the Lemielle, and the now well-known chimney lamp of Mueseler be permitted for use, provided that their construction and dimensions were the same as the examples placed in the bureau of the Ingénieurs des Mines. The third report deals with trials made with the Mueseler lamps in practical working, and confirms the favourable opinion already expressed.

The South Shields Committee tested the following lamps:—the Davy, Stephenson, Clanny (the fourth, fifth, and probably sixth lamps), the Upton & Roberts, and the lamps of Henry Smith, Wm. Martin, and Richard Ayre. The Committee issued their report in 1843, and came to the following conclusions:—

"No mere safety-lamp, however ingenious in its construction, is able to secure fiery mines from explosions; and that a reliance on lamps alone is a fatal error, conducive to those dreadful calamities which they are intended to prevent . . . The naked Davy is, without a complete shield, a most dangerous instrument.

"The best description of lamp to be employed is that on the principle of the Improved Clanny and the Mueseler lamps, the latter with a continuous gauze cylinder."

In 1840 Dr. G. Bischof, Professor of Chemistry in the University of Bonn, conducted tests on the Davy lamp, and obtained results which agreed with those of Davy.

The lamps tested by the Commissions are shortly described in the paper.

It was during this period that Clanny produced two more lamps (his fifth and sixth) and that Mueseler invented his lamp with the chimney. Clanny's fifth lamp consisted of a internal gauze cylinder, completely surrounded by an impervious metallic shield having glass and lenses in its side and only open at the highest part of the gauze cylinder for about 1½ inches from the top. There was a ½-inch air-space between the cylinder and the gauze, and air could only enter the lamp after passing over the top of the shield. The lamp was subsequently modified by surrounding the portion opposite the flame with a "thick globular" shield of glass. The sixth lamp was constructed on the plan of the well-known Clanny, namely, with a glass cylinder surrounding the flame and a gauze

cylinder doubled at the top fitted closely on to the glass.*

The Mueseler lamp tested by the Belgian Committee introduced the chimney inside the gauze, and was similar in construction to the unbonneted Mueseler of to-day. The air was taken in above the glass cylinder, and had to pass through a horizontal gauze fitted between the top of the cylinder and the chimney. The unprotected glass cylinder surrounding the flame was considered to reduce the safety of the lamps.

Period 1841 to 1866.—During this period three Select Committees were appointed in England between 1849 and 1854 to inquire into accidents in mines. In the reports of Committees appointed in 1849 and 1852 the Davy lamp was criticised on the score of giving defective light and want of security in a strong explosive current. The third Committee pointed out that opinions as to its security varied, but the majority were in its favour.

Inventors appear to have been active in this period, for a considerable number of lamps of both types were introduced. These lamps are referred to in the paper. It is only necessary here to mention the "Jack" lamp, a shielded Davy in which the gauze was protected by a glass cylinder that extended from a short distance above the bottom of the gauze to the bottom of short gauze-cap or smoke-cap. The "Tin-can" Davy was introduced in 1866, and consisted of a Davy lamp closed in a tin casing with a glass window. In order to improve the light given by the Davy, the "Reflecting" lamp was introduced, polished gauze being used and a polished cone being placed below the flame to reflect the light. Two gauze cylinders were used, the inner one "being placed at such a distance from the outer that the firedamp enclosed between the cylinders (if the flame passes the first) explodes and may extinguish itself."

Period 1867 to 1879.—During this period several investigations on safety-lamps were conducted, the chief of which were those of the North of England Institute of Mining and Mechanical Engineers; of the Belgian Government; of the Société de l'Industrie Minérale in France, and of Messrs. Smethurst and Ashworth. Several new lamps were introduced, but the only new type of lamp was the Gray. The tendency appeared to be to attain a high degree of safety by increasing the complexity of construction. The results of the various investigations showed the insecurity of the Davy in currents exceeding seven to eight feet per second, and in the report of the French experiments the use of the Shield (*écran*) is advocated. The Belgian Commission appears to have reported in 1873, and as a result the use of the Mueseler type of lamp was made obligatory in fiery mines. The experiments of Messrs. Smethurst and Ashworth confirmed Davy's results on restricting the diameter of the gauze cylinder.

Period 1880 to 1887.—This period was one of great activity in the investigation of safety in mines. The following Commissions were appointed:—The French Firedamp Commission of 1878-1882; The Prussian Firedamp Commission of 1880-87; The Saxon Firedamp Commission of 1880; and the British Royal Commission of 1879-1886. In addition, experiments were carried out by the Midland Institute of Mining, Civil, and Mechanical Engineers in 1884; by Mr. A. R. Sawyer in 1884-1885; and by the Mining Institute of Scotland in 1886. The reports of these Commissions contributed materially to the growth of knowledge on the subject. The principal results are given in the paper. The importance of the shield or bonnet in increasing the safety was frequently insisted on, but its use was in some cases objected to, as it concealed the gauze from inspection. A very large number of lamps were designed and submitted to tests. It is only possible to mention one of them here, namely, the Marsaut lamp. The first lamp introduced by Marsaut was a bonneted Boty or Clanny, with a chimney, derived from the Mueseler by suppression of the gauze diaphragm. On experimenting with his lamp by raising it into a glass bell containing illuminating-gas and then lowering and stopping it opposite to the edge of the bell (in order to cause an internal explosion at the height at which the gas was mixed with air in suitable proportions), ignition of the gas in the bell took place at nearly every trial. This phenomenon, known as "l'effet Marsaut," occurred with several other lamps when similarly tested. As a result of these experiments, Marsaut was led to construct the well-known Marsaut lamp. The gauze diaphragm and Mueseler chimney were replaced by an interior gauze. The large surface of this additional gauze offered means for the better cooling and escape of the gases. The gauzes were protected by a bonnet, with holes at the bottom for the admission of air, which was taken in over the glass and had to pass through both gauzes and holes at the top for the escape of the products of combustion. This lamp did not show "l'effet Marsaut."

Period 1888 to 1913.—The most striking features of this period are the large number of official stations erected for testing safety-lamps and the improvement in apparatus used. Stations have been installed in Great Britain, at Eskmeals, in France and in Belgium, and in Westphalia, Silesia, and Saxony in Germany, whilst the Austrian station at Mährisch-Ostrau used by the Commission of 1881 to 1891 appears to have been maintained; experiments were also carried out at Karwin.

* On March 25th, 1846, a paper by Dr. Clanny on his safety lamp was read before the Society of Arts, in which the lamp was fully described, and a specimen exhibited. The lamp was referred to the Committee of Chemistry, which discussed the paper and received evidence from a number of persons as to the efficiency of the lamp. The Committee resolved: "That Dr. Clanny's lamp will give a superior light to the wire gauze lamp in common use in coal mines, and might be equally safe, but they cannot recommend to the Society to take upon themselves the responsibility of recommending a new safety lamp, as they are not aware of any evidence of an explosion having occurred where the wire gauze lamp has been used with ordinary care."—H. T. W.

Considerable improvements have been made in the construction of lamps so as to secure strength in the various parts and to facilitate the operations of cleaning and assembling the lamps. Much attention has been given to the question of locking arrangements, and magnetic locks have come largely into use. Arrangements for lighting lamps by electric means after they have been assembled have been largely adopted, and in Great Britain, France and Belgium the efficacy of the bonnet has been fully recognised. In France, Belgium, and Germany the use of internal relighters is very generally approved, but not so in Great Britain. The question of illuminants has also received much attention, and even acetylene lamps have been introduced. Among the more important lamps of this period may be mentioned the Howat "Deflector" lamp, the Ashworth-Hepplewhite-Gray, the Thorneburry, the Fumat, the Body-Firket, the Wolf, and the Hailwood "Combustion-tube" lamp. As the result of recent experiments, there has been a tendency to restrict the use of lamps by legislation to "permitted" lamps. This has been done in Great Britain, France, and Belgium. A number of the modern lamps are described in the paper, but it would appear unnecessary to do so here, as their construction is more or less familiar.

The authors have brought their paper to a close at the end of the year 1913 because they consider the history of the safety-lamp as commencing in 1813, although the Davy lamp was not invented until towards the close of 1815. Another reason which decided them to adopt this course has been the difficulty of writing about contemporary events, for since the outbreak of the great European war in August, 1914, the course of events has not been normal, and possibly the development of the safety-lamp has been in consequence arrested.

ENGINEERING NOTES.

Twenty Millions for a City and Suburban Railway in Australia.—We have just received from Mr. Joseph Davis, M.Inst.C.E., Director of Public Works, New South Wales, a very comprehensive and carefully-studied report concerning the proposed city and suburban railways for Sydney, viz., the electrification of the inner zone of existing suburban railways to Parramatta, Hornsby, Sutherland, and Bankstown; the construction of the City Electric Railway, and electric railways to the eastern, western, and northern suburbs; the construction of two long-span cantilever bridges across the harbour of 1,600 ft. and 1,350 ft. centre spans respectively; the electrification of the outer zone suburban railways to Penrith, Campbelltown Waterfall, the Hawkesbury River, and various other small branches in the suburban area; and the construction of underground tramways. The cost of these works, which have been approved, will be approximately twenty million pounds sterling, exclusive of land purchase, which will be a very large item, and they will be carried out in the order indicated above. The subject was referred to in "Engineering Notes" of January 8th and February 5th, 1915, but we now have detailed information which shows the project to be a most ambitious one, entailing, in the neighbourhood of the city of Sydney and suburbs alone, an expenditure on railways and tramways which is probably unrivalled compared with any town of its size in the world.

Radio-Telephony.—The *Engineer* says, on this subject, the transmission of speech without wires is a problem with which scientists and electricians have been dealing in one way and another for a good many years, though it is doubtful if anyone imagined until quite recently that radio-telephony could be efficiently established across the Atlantic. Speech, however, has actually been transmitted between the giant station at Arlington, near Washington, and the Eiffel Tower. The achievement is all the more remarkable when it is remembered that not a word, or even a sound suggestive of a word, has ever been transmitted through an Atlantic cable, nor is there reason to think that this will be possible whilst present methods are in vogue. Working jointly, the American Telephone and Telegraph Company are said to have obtained results little short of marvellous considering the distance involved. To American engineers the credit for this achievement belongs, but it must not be imagined that wireless experts in this country have done nothing in this particular field. As far back as 1913, Mr. Round, of the Marconi Company, carried on conversation without wires between Marconi House and Berlin. In fact, such excellent progress was being made that had it not been for the intervention of the war the Marconi transatlantic stations would in all probability now be in wireless telephonic communication. Next to nothing of a technical character concerning the tests between Arlington and Paris has been published, although there is reason to believe that the methods adopted are very similar to those employed in the latest experiments conducted by Mr. Round. It is doubtful if radio-telephony will ever supersede the present wire system for short distances over land, but it will undoubtedly be of immense value where the wire telephone is impracticable. The development of radio-telephonic apparatus has been a slow and laborious process, involving much perseverance and expense. At times any real measure of success appeared hopeless, except for short ranges of transmission. But now that speech has been transmitted between Paris and Washington the outlook is altogether different, and there is every reason to believe that sooner or later radio-telephony will establish itself

permanently as a means of communication throughout the world. The *Times*, in connection with the above, says the national meeting of the American Institute of Electrical Engineers held in June involved simultaneous sessions in San Francisco, Chicago, Atlanta, Philadelphia, Boston, Salt Lake City, Denver, and New York, all these being connected together by the long-distance telephone circuits of the American Telephone and Telegraph Company. Over 5,000 members and guests were present, there being 500 at Atlanta, 700 at San Francisco, 900 at Boston, 850 at Philadelphia, 1,000 at Chicago, and 1,100 at New York; while fifty members at Denver and forty at Salt Lake City listened to the proceedings but were not connected so as to take part. The meeting began in New York at the scheduled time, and from that point the roll of the cities was called, the section officers presiding in the other cities responding with a statement of the attendance at each place. Mr. H. W. Buck, the president-elect, made a short speech of acceptance to the members gathered in the different cities. As regards the reports made at the meeting, the officers presenting them were not all at New York, and in a number of cases motions made in one city were seconded in another and discussed by several members in still other places. After the business was transacted each section held a strictly local session with an address by some prominent speaker. At the end of the local sessions the long-distance lines were again brought into use. The meeting was addressed by Dr. M. Pupin, speaking from New York, and closed with a general greeting to the members from the secretary, also in New York.

Hydro-Electric Power in Tasmania.—Great Lake, hitherto chiefly the resort of anglers, has been utilised to furnish water power for the generation of electricity for distribution to Hobart and throughout Tasmania. The project, which is now practically complete, will provide 26,000 h.p. at the turbine shafts for twelve hours a day, or 39,000 h.p. for eight hours a day, and it is believed that the amount can eventually be increased to 70,000 h.p., according to the report published by the *Board of Trade Journal*. According to the account of an interview between the British Trade Commissioner for Australia and the general manager of the Hydro-Electric Department of the Tasmanian Government, the latter had at the time already made arrangements for the sale of about 9,000 h.p., and was carrying out a publicity campaign with the object of bringing the scheme to the notice of Australian merchants and others desirous of obtaining light and power. Works for the manufacture of calcium carbide were projected, and apparently United Kingdom interests were investigating the possibility of installing woollen mills. The general manager considered that there will be an increased demand in Tasmania for electrical fittings and appliances, and he suggested that the time is ripe for more active steps to be taken by United Kingdom manufacturers for bringing this class of goods to the notice of consumers. Hydro-electrical instalment was effected a dozen years ago, in the case of lighting the town of Launceston, the second in importance to Hobart, the capital of Tasmania. This water is drawn from local sources, not from the Great Lake as in the present case.

Humphrey Gas Pumps.—The best-known type of Humphrey gas pump is that in which a long column of water is caused to oscillate to and fro in a play pipe by the explosion of combustible gases acting direct on the water. This type, while adapted for dealing with large quantities of water, as at Chingford reservoir, is not so suitable for smaller installations. The Humphrey Pump Company have therefore brought out a two-cycle direct-acting internal-combustion pump based on the same principle as the water-column pump, but introducing a piston between the gases and the water. The *Times* remarks, in reference to the foregoing, the pump in appearance is very similar to an ordinary vertical direct-acting steam pump, the combustion cylinder being at the top and the water cylinder underneath. The method of operation is as follows: Assuming the piston in the internal-combustion cylinder to be at the bottom of the stroke with a compressed charge below it, on ignition this piston is driven upwards carrying with it a cast-iron weight, which is fixed to the top end of the piston rod. Side rods are also fixed to the weight and secured at the other end to a crosshead carrying the end of the pump rod; on one of these side rods is fixed a cam which opens the exhaust valve when the piston has attained a certain height. The exhaust valve being open, the pressure underneath the piston falls to that of the atmosphere. The upward motion of the piston, however, continues in virtue of the momentum already acquired, and a little later the piston passes the ports in the cylinder, these ports communicating with an annular space chamber surrounding the upper part of the cylinder. Into this chamber the upward motion of the piston had previously compressed a charge of air and gas. This charge now escapes through the ports into the cylinder below the piston. At or near this part of the stroke the energy imparted by the charge has been entirely expended (1) in raising water, and (2) in lifting the weights, and the piston comes to rest. The piston now returns and compresses the new charge into the clearance space; and at the end of the stroke this charge is fired, and a new cycle begins. During the down stroke a new charge has been drawn in above the piston through a

non-return gas valve. An air-cushion is provided between the weight and top cylinder cover to prevent accident in event of exhaust valve leaking or breaking. To start the pump the piston is raised by a barring lever and a charge allowed to accumulate beneath it. The lever is then tripped, allowing the piston to fall, compress, and fire the charge. In the larger sizes a screw with ratchet attachment is used in place of the barring lever. It will be obvious that all the work is done on the upward stroke, and that the water in the pump is circulated only on the downward motion. The pumps will work on town gas, producer gas, or petrol. Compactness and lightness are the objects aimed at in the design. The smallest size (3 in.) made at present weighs only 350 lb., and can deliver 3,000 gallons an hour at 33 ft. head, with a fuel consumption of 20 cubic of gas, or ⅜ pint of petrol an hour.

OBITUARY.

Sir Robert Gray Cornish Mowbray, Bt.—Sir Robert Mowbray died on the 23rd inst. at Mortimer, Berkshire. He was born in 1850, and was educated at Eton and Balliol. He was elected a Fellow of All Souls in 1873. In 1876 he was called to the Bar at the Inner Temple. From 1886 to 1895 he sat in Parliament as member for the Prestwich Division of South-East Lancashire, and he represented the Brixton Division of Lambeth from 1900 to 1906. He served on several Royal Commissions, and as Parliamentary Private Secretary to Mr. Goschen, when he was Chancellor of the Exchequer, from 1887 to 1892. In 1900 Sir Robert was elected a life member of the Society, he having served as Prime Warden of the Goldsmiths' Company in the previous year, and being nominated by the Court of that Company under the annual subscription given to the Society. In 1903 he presided at a meeting of the Indian Section, when a paper on the Indian Census was read by Sir J. A. Baines, C.S.I.

NOTES ON BOOKS.

Robert Adam and his Brothers. By John Swarbrick. London: B. T. Batsford. N.D.

To all dwellers in the Adelphi anything connected with the life of Robert Adam must be of extreme interest, and the Society of Arts is quite the oldest inhabitant of the district, while it occupies what has always been its most important building.

Considering that Robert Adam died only a century and a quarter ago, and considering also the great reputation which he possessed in his lifetime, a reputation which has endured up to the present date, it is remarkable that not more is known about the man himself. We know something of his family, of his education and early friendships. We know how he visited Italy, and of the careful study he made of Diocletian's Palace in Dalmatia, so that when he returned to England, a man not much over thirty, he brought with him such a reputation that he was appointed architect to the King. We know, too, that he was popular and well known in society, and that he enjoyed the benefit of high patronage; while, as the late Mr. Cosmo Monkhouse points out in the "Dictionary of National Biography," his social position was attested by the fact that when he was buried in Westminster Abbey his pall-bearers included a duke, two earls and a viscount. But, after all, of his personal history we know really very little, and there is not very much about him in contemporary literature. Horace Walpole speaks of him, not with much approval. Fanny Burney met him, and recorded the fact in her diary; and there are, of course, other references, but they are not very numerous.

With regard to his works, it is quite another matter. It has been said of Robert Adam that he worked in the fashion of the elder Dumas, having a number of assistants, or according to the modern professional slang "ghosts," who were under his direction and carried out his ideas. Not only had he the assistance of his brothers, especially James and William—though the latter is believed to have managed mainly the business side of the brotherhood—but he brought over a number of Italian artists, who helped him, and besides these he appears to have employed a little army of subordinates. No one man could have done in a lifetime of sixty years the work which Adam left behind him, unless he had been able to depute the execution of a very large part of it to others.

And his works were as various as they were abundant. He was apparently most proud of the country houses which he built, and he had his full share in the construction of the numerous country mansions which provided so much employment for the architects of the eighteenth century; Fergusson says that in that century there were 200 erected. But he left his mark both on London and on Edinburgh. In the former city there are numerous houses which he built, modified, or decorated; and it is in London that his most remarkable, if not his greatest, work is to be found—the Adelphi, a private speculation of his own, which nowadays would certainly have been undertaken by the municipality.

Most of these buildings still remain to testify to Adam's genius, versatility and industry. But besides the buildings themselves there are copious literary records of them. The "Works in Architecture" was published in numbers from 1773. The various parts made two volumes, published in 1778 and 1779, and a third volume was published much later, in 1822. These are magnificent books of large folio size, full of fine engravings by Francesco Bartolozzi,

Antonio Zucchi, Domenico Cunego, Giovanni Vitalba, Benedetto Pastorini, Thomas Vivarez, Francis Jukes, James Caldwall, Edward Rooker, Thomas White, Robert Blyth, and others.*

Amongst the engravings we find the elevation of the front of the Society's House, which served as the frontispiece to Volume VIII. of the *Transactions*, and was reprinted from the original plate as the frontispiece to the recent History of the Society. But it is on a much larger scale, filling up the whole of the great folio page. Then there are the fifty-two large folio volumes of designs in the Soane Museum, including in all some 8,000 drawings and sketches.

The writer, therefore, of any fresh book on Adam's work has abundant material, and of it Mr. Swarbrick has availed himself fully and with considerable judgment. He has also added a number of original photographs of some of Adam's buildings and interiors, as well as reproductions of portraits of Robert and James. These are all produced in the manner for which Mr. Batsford has made a reputation, so that the volume is a very beautiful one, and a fine example of the best class of modern illustrated book. At the same time it is impossible to avoid a feeling of regret in comparing the splendid original engravings on thick linen paper with the modern work, fine as it is, on paper which must of necessity consist to a large extent of some mineral matter capable of providing an absolutely smooth and polished surface. One wonders how in another hundred years Mr. Batsford's beautiful book will compare with its predecessor of the end of the eighteenth century. Each age, however, must produce its own work in its own way, and modern reproductive processes are not capable of anything much better than that which Mr. Batsford and his author have given us.

If there is not a great deal which is new, it is because there is not very much that is new to be provided. The work of Adam (for it really was the work of Robert) is, of course, perfectly well known, and has been very fully discussed. There is room for an abundance of difference of opinion about it. There can, however, be no doubt whatever of the enormous influence that it had, not perhaps so much on architecture proper, but unquestionably on decorative art of every sort, not only architectural. After all, Robert Adam was a decorator and a designer rather than an architect (spite of all his houses), and it is because of his decorative work that his fame is still alive. He influenced his contemporaries as well as his successors, and he founded a school of permanent value. It is not merely a vagary of fashion that, after being decried and depreciated by the artists of the Gothic school, the Adam's style is now coming to the front again, and receiving its full measure of appreciation.

As was naturally to be expected, it is to the works of Adam that Mr. Swarbrick has devoted all his attention, for though the book professes to deal with the lives and work of the brothers, as well as with their influence on English decoration and furniture, there is practically no addition to our knowledge of the men themselves.

One queer little slip may be pointed out, though without any desire to find fault. It is stated that Robert Adam was elected a member of the "Society of Arts in St. Martin's Lane" in 1758. Now Robert Adam was elected a member of the Society of Arts in 1758. The Society at that time was only four years old: it will thus be seen that Robert was a very early member. In that year the Society occupied a house at the corner of Castle Court, opposite the New Exchange. It is by no means likely that he was ever a member of the well-known academy in St. Martin's Lane, and his name is not given in the only list of members of that academy which is known to the present writer—that by W. H. Pyne, the author who wrote under the name of Ephraim Hardcastle. Pyne's list was compiled from memory, and published years after the St. Martin's Lane academy had disappeared, and what was left of it merged into the Royal Academy, but it is fairly full, and probably the name of so well-known a man as Robert Adam would not have been overlooked.

To counterbalance this little bit of criticism, we may offer our thanks to Mr. Swarbrick for reproducing (opposite page 76) the knocker which still adorns the door of the Society, as well as an excellent photograph of its House.

* The whole work was finely reproduced by a French publisher in 1900 and following years.

GENERAL NOTE.

Educational Books for British Prisoners of War.—Arrangements have been made, with the approval of the Foreign Office, for extending to British prisoners of war interned abroad the benefits of the scheme, which has been in operation for the last year in connection with Ruhleben, for supplying selected books of an educational character to those of the interned who may be desirous of continuing their studies in any subject. An appeal is therefore now made for a plentiful supply of new or second-hand books of an educational character (light literature and fiction is available from other sources) to meet the needs of the many thousands of British prisoners interned in enemy or neutral countries. It is to be hoped that to this appeal there may be a liberal response. A circular explanatory of the educational book scheme can be obtained by sending a postcard addressed to the Board of Education, Whitehall, S.W., to Mr. A. T. Davies, who is in charge of the arrangements.

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FRIDAY, AUGUST 4, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

INDIAN SECTION COMMITTEE.

The following is the list of the Indian Section Committee, as appointed by the Council :—

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

OPTICAL GLASS.

By Walter Rosenhain, D.Sc., F.R.S.,
Superintendent, Metallurgy Department, National Physical Laboratory.

Lecture I.—Delivered November 29th, 1915.

The national importance of the whole question of optical glass is so fully recognised at the present time that when I was invited by the Society of Arts to deliver a course of Cantor Lectures on this subject I felt unable to decline that invitation, although intense preoccupation with other matters—including the practical side of this very subject—made it a matter of extreme difficulty to devote the necessary time and energy to the preparation of lectures of any sort. It is by now a commonplace to say that optical glass is of first-rate importance in connection with war, both on sea and land; and it is also well known that the outbreak of the present war found us unable in this country to produce, without much delay and difficulty, a supply of glass adequate in quality and quantity to meet the demands of the army and navy. Since that time very great efforts have been made, and a very considerable measure of success has been attained so far as meeting the immediate requirements for war purposes is concerned. Still, even that measure of success is not yet entirely sufficient, and we have, besides, to look a good deal further in such a matter. We must not be content with tiding over the present difficulty by what may well be termed eleventh-hour heroic measures. Now that it has been brought home to us that the production of optical glass has become an industry of national importance, it behoves us to see that we shall never again drift into anything like dependence upon any foreign country for one of our vital requirements. We have to see to it that in regard to this industry we

shall achieve not only equality with the best that is done elsewhere, but that we shall put forth our best efforts to attain a leadership in this as in other technical matters. I am happy to say that this point of view has been most fully recognised by those in authority, and as at least one step in that direction, the Government have provided the National Physical Laboratory with reasonable funds for the purpose of initiating extensive research into the fundamental problems which beset this whole industry of optical glass manufacture. It is one of the objects of these lectures to set out the nature of some of these problems, by describing first the nature and properties of optical glass, and particularly those properties which distinguish it from ordinary glass; the present process of manufacture will then be described—and I am fortunate in having had over five years' actual experience of that process on the industrial scale. I shall then hope to analyse the present process in such a way as to make clear the causes of difficulty, and to show the limitations and possibilities so far as our present knowledge of glass allows us to formulate them. This general survey, brief as it must necessarily be, will perhaps serve to clear the ground and to enable those who, like myself, may be approaching this subject from the point of view of researches directed towards the improvements which are needed, to realise more fully than is possible from other existing literature what are the principal factors of the problem before us.

What, then, are the fundamental properties which distinguish "optical glass" from "ordinary glass"? We must guard ourselves at the outset from misconception by remembering that the term "optical glass" is used to cover a fairly wide range of material in regard to quality. Thus the cheap glass, which can be used for very small and low-power telescopes, is a very different material from the best kinds of optical glass used for the lenses and prisms of a range-finder or a large telescope. Thus ordinary plate glass of good quality is used in large quantities for the production of certain types of small and cheap lenses, while some of the cheap pressed lens-blanks which were produced in such very large quantities in France are really of no higher quality. In order, however, to narrow the range somewhat, it will be well, in what follows, to confine the term "optical glass" to the best kinds of glass, such as would be fit for use in the best optical instruments.

If we think of "optical glass" in that way, it is readily distinguished from even the best of ordinary glass by a whole series of important properties. These can, however, be summed up in two groups: (1) Properties relating to "general quality," in regard to which "optical glass" is simply a "better quality" than ordinary glass; and (2) Properties of a more specifically "optical" kind, relating to the refractive and dispersive powers of the glass. In regard to these, optical glass must meet certain definite and stringent requirements which are not at all applicable to glass used for other purposes. It will be convenient to discuss these two groups of properties separately and in the order named, since the first group is applicable to all kinds of optical glass, while the second group vary from one kind of glass to another.

Of the general properties of glass, that which is most important for optical glass is "transparency." If we use this word in its widest and strictest significance, it denotes the power of transmitting light without diminution as to quantity and without introducing any irregularities or disturbances into its path. We commonly think of an object as "transparent" when we can "see clearly through it," but the object is perfectly transparent only if we can "see through it" as perfectly as if it did not exist at all. The only really close approach to a perfectly transparent material—if we may call it that—is a perfect vacuum, *i.e.* the free ether. But even in inter-stellar space there appears to be some very slight power of absorbing or scattering light. In dealing with glass, therefore, too great a degree of perfection need not be expected; and it is surprising to find how very "transparent" good optical glass of the best kinds really is. It requires very refined measurement indeed to show that there is any absorption of light at all in such glass—at all events in the range of visible light. For the short waves of the ultra-violet region and for the long waves below the red end of the spectrum, however, glass—no matter how pure and clear—still shows very strong powers of absorption.

If now we consider how the best optical glass differs from ordinary glass in this matter of transparency, we shall immediately touch upon some of the most important properties of glass from our present point of view. First, as to *colour*. The quality of ordinary glass, such as tableware or window glass, is most usually judged by its colour; but this judgment is

apt to err, because the apparent colour of a given quality of glass depends so very much upon how it is examined. Looking through a sheet of window-glass in the ordinary way, we are scarcely conscious that it is at all coloured. If we take a piece of the glass and lay it down on a sheet of white paper, we notice a slight tinge of colour, because now the light, instead of merely traversing one thickness of the glass, has had to pass through it twice—once before it reaches the paper and a second time after being reflected back by the paper. The effect of contrast with that part of the white paper not covered by the glass is a further help. The colour of the glass, however, only becomes strikingly apparent when, instead of looking through the glass and allowing the light to traverse a thickness of only one or two tenths of an inch, we look lengthwise through a long strip in such a way that the light has to traverse a thickness of ten or twelve inches of glass. Examined in that way, ordinary window glass looks a deep sea-green; even the purest and best of optical glass shows a noticeable colour when light has to traverse it in great thicknesses. This phenomenon gives rise to a curious effect which is obtained when a large block of good glass is placed beside a heap of small pieces made of a precisely similar block of the same glass: while the single large block looks distinctly coloured, the heap of small pieces looks absolutely free from any trace of colour.

For good optical glass, the greatest possible freedom from colour is generally demanded, and since in the majority of glasses colour is the result of the presence of impurities in the glass, this demand can be met by adequate care in manufacture and in choice or preparation of raw materials. Various kinds of glass, however, differ widely in sensitiveness to colouring effect, and an amount of impurity which would produce a negligible effect in a hard crown glass, for instance, would bring about a distinctly green tinge in a dense barium glass. The popular classification of glass according to colour, however, has produced a deep-rooted prejudice against all visible colouration in lenses. This is really a prejudice, because in most optical instruments the thicknesses of glass used are only small, and colouring effects would not be serious. But the result has been rather a curious one. Glass-makers, in order to meet the demand for material free from the greenish tinge associated with the poorer kinds of glass, have resorted to the use of what are known as "decolourisers." These act by the introduction of a compensating or complementary colour into the glass—so that a substance is added which by itself would produce a slightly pink tinge. When this is superposed upon the slight greenish tint of the glass the result is a "neutral" tint in which no definite colour is discernible. For optical purposes, however, this remedy is undoubtedly much worse than the disease—as will appear at once if the manner in which this result is obtained is considered. The glass appears green in the first instance because it absorbs some of the red rays of the light which passes through; if now a pink tint is superadded, this results in the simultaneous absorption of some of the violet or blue rays, so that the absorptions at the two opposite ends of the spectrum are approximately balanced. The result is a neutral-tinted glass which actually transmits considerably *less* light than the slightly greenish glass which it is designed to replace. For most optical purposes, the glass having the greater total absorption is much the worse, so that the demand for "colourless" glass for optical purposes may at times defeat its own object. Ultimately we are, of course, led to the conclusion that the only satisfactory way of producing colourless optical glasses is to do so by the elimination of all colouring impurities, and by entirely avoiding the use of "decolourisers."

While in the majority of glasses the presence of visible colouration is due to the presence of impurities, there is another aspect of the matter which is worthy of brief mention. To pursue this particular matter very far we should have to enter into the details of the very ingenious electro-magnetic theory of refraction and dispersion which is associated with the name of Drude. It will be sufficient, however, to point out that the very transparency of glass is intimately bound up with its electrical properties. Glass is a very excellent electrical insulator for electric impulses which alternate at the enormous rate which obtains in the waves of visible light; if these electrical properties were identical throughout the entire range of electric waves, we should probably find little refraction and no dispersion in our glasses. The dispersion particularly is closely associated with the fact that for some wave-length or rate of alternation lying not very far outside the visible range at either end there is a band or region in which the glass behaves almost like a good conductor of electricity rather than as an insulator—with the result that those particular wave-lengths

are absorbed and the glass is practically opaque for waves of that particular length. In the vicinity of such absorption bands, the differences in the behaviour of light of different wave-lengths become very much accentuated, and consequently the optical properties of a given glass, so far as visible light is concerned, are found to depend upon the distance from either end of the visible spectrum at which these invisible absorption bands are situated. If near the blue end, then the blue end of the spectrum is greatly drawn out, and vice-versa if the absorption lies near the violet end. The interesting point in regard to the visible colour of a glass, however, arises here—for in those glasses in which there is very great dispersion, particularly near the violet end of the spectrum, we should be led to conclude that the active absorption band was situated not very far beyond the limit of the visible spectrum and in extreme cases near enough to that limit to affect the visible colour of the glass. It is interesting to find that the very dense flint glasses, in which dispersion reaches its extreme values, are distinctly yellow in colour. This yellow colour is not due to impurities but is inherent in the glass and closely associated with its most characteristic properties. Not only this—it is further known that the absorption bands of a glass move appreciably when the temperature is changed, and we might expect that in flint glasses not quite so dense as those just referred to, and therefore colourless when cold, the presence of the absorption band near the violet end of the spectrum might make itself felt when the glass was heated, and the band thereby displaced. This is a well-known phenomenon in all the denser flint glasses, which, although colourless when cold, become very decidedly yellow when heated. We cannot pursue this very interesting matter further in this place, but enough has perhaps been said to suggest that the colour and absorbing powers of glass are far more intimately connected with their most important optical properties than one would at first sight imagine.

The transparency of glass will obviously be diminished to a definite extent by the presence in its mass of any substance which is not glass. Such foreign bodies are unfortunately by no means of rare occurrence in glass, and their presence has to be carefully guarded against in optical glass. Bodies accidentally included can, as a rule, be cut out and avoided during the preliminary selection of the glass, and indeed their occurrence can be to a large extent avoided by adequate care during manufacture. There are, however, two types of "foreign body" which are produced within the glass itself, and these are not so easily dealt with. The first of these types are the bubbles or "seed" which are apt to occur in all glass. When glass is melted, the raw materials are introduced in the form of powder and much air is enclosed in this mass. A much larger quantity of gas—mostly carbon dioxide and oxides of nitrogen—is generated by the decomposition, during fusion, of the raw materials, since the glass-making oxides are generally employed in the form of carbonates or nitrates. If the glass-maker is free to adjust his mixture to suit his furnace and mode of working, he can generally arrive at a mixture which evolves this gas in the form of large bubbles which rise rapidly to the surface and carry all their smaller brethren with them —the glass is said to "come to a good boil" and is finally left entirely free from all bubbles. In making optical glass, however, the skill of the glass-maker in this direction is entirely hampered by the restriction that the mixture must produce a definite chemical composition if the desired optical properties of the glass are to be attained. Consequently many of the optical glasses "fine" with difficulty, the mixture generating extremely small bubbles which hardly rise to the surface at all. In some cases there even seems to be a continuous production of fresh bubbles—either by the gradual volatilization of one of the constituents of the glass or by some interaction between the glass and the pot in which it is contained or with the furnace gases diffusing through the somewhat porous walls of the melting pot. In these cases the glass cannot be entirely freed from all small bubbles, and this necessity has been accepted by opticians and by the public—who have both come to recognise that the presence of these small bubbles, which do not diminish the light transmitted by more than 0·02 per cent., is of no appreciable disadvantage to the finished lens.

More serious—where they occur—are the "foreign bodies" of the second type. To understand their nature we must recall the fact that glass is not really a "solid" in the strict sense of the term—it is really a liquid which has "congealed" by becoming gradually stiffer and stiffer, but without ever passing through the definite transformation from liquid to solid which we meet with in the majority of bodies. Most molten substances pass from the liquid to

the solid condition by a definite act or process of crystallization. In most cases, however, this act of crystallization can be prevented by cooling the substance very quickly—as, for instance, by quenching it in cold water. If this is done, the result is a vitreous body possessing some of the properties of glass. The conclusion is fairly well established that glass is really a congealed liquid which has been prevented from assuming the truly solid or crystalline condition by too rapid a rate of cooling. "Too rapid" is, of course, in this sense, a purely relative term, since a rate of cooling which will prevent the crystallization of one kind of substance will be far too slow to prevent another from becoming completely crystalline. If this view is correct, it ought to be possible to make glass assume the truly solid crystalline condition by cooling it very slowly so as to allow the crystals to grow in the thick sluggish liquid. This can be done, but the same result can also be achieved by merely heating the glass to a temperature a little below that at which it would crystallize or "freeze" if very slowly cooled. At this temperature—in most glasses a dull red heat—the glass soon becomes entirely crystalline. In this condition it loses its vitreous nature and becomes an opaque material of an entirely different character. Now in the case of most varieties of glass the rate of cooling must be very slow indeed, or the period of re-heating must be very prolonged, to bring about this crystallization—or "devitrification," as it is called. But when the composition of a glass is pushed to an extreme in order to obtain some desired optical property, it sometimes happens that a substance is produced in which crystallization sets in much more readily, and such a glass, if cooled at the ordinary rate, may be found to be studded with a large number of small specks, each a small mass of crystallized glass. In some cases the crystallization may even extend throughout the glass, reducing it to a porcelain-like opaque mass. In extreme cases this phenomenon makes it impossible to produce satisfactory glass of such a composition at all, while in other cases it is possible to overcome the difficulty by taking steps to cool the glass more rapidly through the dangerous zone of temperature.

We have next to deal with the most serious of all the obstacles to "transparency" which is met with in glass. These are the "striae" or veins which exist in all ordinary glass, and which must be removed before glass can be used for the higher purposes of optics. The nature of "striae" is most readily understood by glancing at any piece of ordinary glass which has been polished on two opposite faces—as, for instance, a piece of ordinary plate-glass which has been polished on its *edges*. Their nature and mode of formation, as well as the means for removing them, can be well studied by pouring a little glycerine into a glass or beaker, and then pouring some water on top of it. As soon as the two liquids begin to mix—which can be brought about by stirring them with a glass rod — strongly-marked "striae" make their appearance, and these can only be made to disappear by prolonged and vigorous stirring. What happens is that the two liquids do not dissolve in one another rapidly, and mixture takes place by the intermingling of layers and streams of the two liquids. As they possess different densities and different refractive indices, the rays of light traversing the liquid are refracted and even reflected and scattered at all the bounding surfaces between these layers and streams, and the liquid thus becomes turbid and distinctly non-transparent. Only as the stirring proceeds, and the two liquids gradually become entirely mingled and dissolved in one another, does the turbidity disappear, until at last the mixed liquids are perfectly limpid and clear again. The same series of phenomena—or at least the earlier stages of the series—occur in the melting of glass. Glass is a mixture of a number of chemical substances, which can be made to assume the state of complete mutual solution, much as glycerine and water can be made to do; but when the glass is simply melted, the various molten liquids which are present in it are not generated in the form of a homogeneous solution, but in streaks and streams and layers, much like those which are formed in the earlier stages of mixing of glycerine and water. So far as we have yet gone, however, we should expect that vigorous and prolonged stirring would effect satisfactory mixture, and would entirely eliminate striae. Unfortunately, however, there are other causes at work which militate against such a result. The most serious of these is the interaction which takes place between the crucible or pot in which the glass is melted and the glass itself. Glass in general, and particularly the more extreme kinds of optical glass, unfortunately possesses the power of attacking and dissolving the substance—fireclay—of which glass-melting pots have always been made, and the resulting solution, which contains a fairly large proportion of alumina derived from the pot, is a

particularly "thick" or viscous liquid which only mingles slowly and grudgingly with the rest of the glass. During the progress of any stirring operation, this interaction of glass and clay continues, and if care is not taken to keep the stirring implement away from the walls of the pot fresh striaĕ are constantly stirred into the glass. Stirring is thus an operation which has to be conducted on a principle of compromise between opposite difficulties, and it cannot therefore be carried out to completion. The result is that—at best—only a small proportion of the contents of a pot are obtained free from striae.

The absence of striae in finished lenses is of such vital importance that it becomes necessary to examine glass intended for important work very carefully before taking it into use. Gross striae can be easily seen with the unaided eye, provided that they are looked at from a suitable direction. Thus, in plate glass and in ordinary window (sheet) glass there are very plentiful striae, but they are not very evident when we look through the glass in the ordinary way,

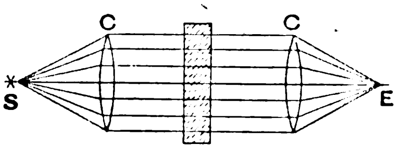

FIG. 1.

because we look through fairly uniform layers of them, each layer being parallel to the surface of the glass. If such glass is polished on its edges, however, and we look through it in a direction parallel to the original surface, we see the striae very clearly. In optical glass the striae are never so pronounced as in plate-glass, and at times they can only be detected by careful observation and with instrumental aid. The best method is to place the glass in a beam of parallel light, and to look at it through a lens or eye-piece which condenses the parallel beam so as to enter the eye. If the glass is free from striae, it appears, in these circumstances, uniformly bright. Striae at once make their presence apparent by disturbing the uniform illumination, producing either a brighter line or a dark shadow, according to the precise conditions. A sufficient approximation to parallel light can be obtained for this purpose by looking through the glass at a small source of light a few yards away, but a more convenient arrangement is that shown in the diagram (Fig. 1).

We have yet to deal with one further defect which frequently occurs in glass—this is internal strain, such as tension or compression, or a combination of both. In ordinary glass this condition frequently exists to a very considerable extent, but provided that the strain is not severe enough to bring about rupture, very little harm is done. In the case of optical glass, however, matters are very different, for the optical properties are materially altered by strain, and since in a finished lens the strains are rarely symmetrically distributed, a distortion of the image is produced. It is therefore of fundamental importance, for all the better kinds of optical work, to secure glass entirely free from internal strain. Fortunately, although this defect is not at all easy to eliminate entirely, it differs from such defects as colour or striae in that it can be removed from the finished glass without re-melting. What is needed is extremely careful annealing. This will be readily understood when the origin of the internal strains in glass is considered. They arise during the cooling of glass from the molten or soft condition. The outer layers of glass naturally cool and stiffen, while the interior of the mass remains hot; but the outer layers during cooling have been fairly free to contract. The inner layers, on the other hand—when in turn they cool down—are not free to contract, because they are held by the stiff solid outer layers. The tendency to contract as they cool is thus resisted so far as the inner layers are concerned, and these consequently remain under a very severe tension, while the outer layers, being obliged to resist this tension, are subjected to very severe compression. If the rate of cooling is rapid, these stresses may become so severe that fracture results. In other cases fracture may only occur after weeks or months. In the case even of badly-annealed optical glass the stresses do not approach this degree of severity, but they are severe enough to spoil the glass for optical uses. The remedy is, of course, obvious—the rate of cooling must be reduced to such an extent that the setting of the inner and outer layers is approximately simultaneous, so that all parts of the glass may be permitted to undergo their natural contraction during cooling. The actual rate required is extremely slow, and it must be perfectly steady, since a short but rapid variation of the temperature may spoil the whole process.

The presence of strain in glass is readily detected by the use of polarised light, since strained glass exhibits double refraction to an

extent which varies with the amount of strain which is present. Glass may be examined between crossed Nicol prisms, but since these, unless very small, are extremely expensive, it is best to use a dark reflecting surface, such as a sheet of black plate-glass, as the polariser, using a small Nicol prism as analyser, holding it in such a position that the light is reflected from the plate-glass at the polarising angle, as indicated in the diagram (Fig. 2). The glass should be placed on a stand (not held in the hand) in such a way that the light passing through it reaches the analyser. Examined in this way, a badly strained piece of glass exhibits brilliantly-coloured patterns resembling the crosses and brushes seen in crystals under polarised light. Slightly-strained glass merely shows a few dark and light patches, while thoroughly well-annealed glass shows only the slightest shading, and even this is absent in the best examples.

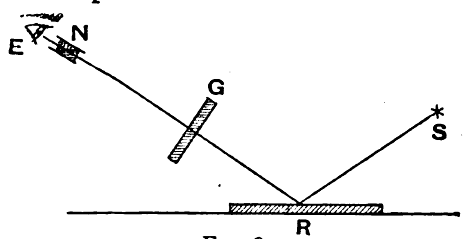

FIG. 2.

We have now considered most of those properties in which optical glass differs most strikingly from ordinary glass, but two others remain to be mentioned which, while undoubtedly of importance for all kinds of glass, become increasingly so for optical glass. The first of these is "hardness." Of this property no very accurate definition can be given, and its actual measurement is correspondingly troublesome. It may be measured by abrasion, by indentation, by resistance to scratching and other methods, but this very variety of method shows how indefinite is the idea conveyed by the term "hardness." In the case of glass for optical purposes, however, "hardness" is of importance only in two directions, viz., in regard to the resistance of the glass to the abrasive processes which are applied to it during the manufacture of lenses, and the resistance of the surface of the finished lens to accidental abrasion or scratching. Provided that the glass is not excessively hard or soft, however, these considerations are generally overshadowed by much more serious factors, so that "hardness" is rarely considered in relation to the optical uses of glass. It is worth taking into account, however, where other factors permit, and at least an effort should be made to use the hardest available glass for the externally-exposed members of a lens system.

Of far more vital importance for optical purposes is the question of the durability of different kinds of glass. It must be noted at once that in this respect glasses differ very widely from one another—in fact, in certain glasses, such as the borate flint and the phosphate crown series, glasses which would otherwise be of the greatest value for optical purposes have had to be abandoned because of their insufficient durability. Want of durability in a glass simply implies that it does not adequately resist the chemical action of the atmosphere, moisture, or the contact with those materials with which it is touched in use. The best glasses—such as certain of the "hard crown" and "boro-silicate crown" types—are remarkably indifferent to all chemical actions, and the moisture and carbon dioxide of the air, as well as the organic matter present in dust and liable to be left on glass surfaces when touched with the fingers, produce no appreciable effect upon them. Some glasses, on the other hand, while not readily attacked by moisture and carbon dioxide, are sensitive to contact with organic matter, and if dust is allowed to gather on such glasses they are liable to become spotted at points where particles of organic matter have rested upon them. These latter glasses are principally the very dense "flint" glasses containing much lead. If the composition of a glass can be chosen merely from the point of view of producing great resistance to chemical action, extremely satisfactory results can be obtained—as, for example, in the modern glass-ware for chemical purposes, which resists the prolonged action both of hot water and of alkalies and acids extremely well. But when chemical composition must be adjusted to obtain specific optical constants, difficulties are apt to arise in this connection. Particularly the presence of high proportions of alkalies, and of such substances as barium oxide and boric acid, tends to render a glass liable to chemical attack by the atmosphere. The worst offenders in this respect are glasses containing much alkali, or containing alkali in a form which leaves it exposed to external attack. So much is this the case that a "durability" test for glass has been evolved which depends entirely upon the amount of alkali which is liberated upon a fresh surface of the glass after a definite exposure to moist air, and by this test it is at present customary to

group optical glasses into definite classes. This test is subject to the very serious limitation that it can take account only of chemical action leading to the liberation of alkali, and consequently glasses which suffer decomposition owing to their excessive content of barium, boric acid, or other substances, are classed among the more durable kinds while in reality they lie nearer the opposite.

The test itself, which is now in regular use at the National Physical Laboratory, is an interesting one. Specimens of the glass to be tested are freshly fractured in such a way as to afford a fairly definite area of freshly-exposed glass. The specimens are then exposed in a closed vessel containing some water—so that the atmosphere is saturated with moisture—for a period of seven days at a temperature of 18° to 20° C. At the end of this time the glass is dipped into a reagent which consists of a water-ether solution of an aniline dye known as Iodesin or Erythrosin B. This dye has the property of combining with alkali, and as a result the artificially "weathered" surface of the glass becomes coated with an extremely thin film of sodium-iodesin. By washing the glass in dry ether, all traces of the uncombined or free iodesin are removed, but the sodium-iodesin remains undissolved. The sides of the pieces of glass are then carefully cleaned, great precautions being taken not to disturb the weathered fractured surface. Finally the sodium-iodesin is removed from the fractured surface by passing the latter through a very dilute solution of sodium carbonate in water. In this solution the pink sodium-iodesin at once dissolves, imparting a pink colour to the solution. The depth of the pink colour of this solution is now measured by careful comparison with a very dilute but accurately standardised solution containing known amounts of sodium-iodesin. The quantities of alkali involved in these manipulations and measurements are extremely minute, but very great accuracy is attainable. The results are expressed in terms of milligrammes of sodium-iodesin per square metre of glass surface—although the actual surfaces employed rarely exceed 5 square centimetres. The classification of glasses at present adopted is as follows:—

	Milligrammes per sq. metre.	
Glasses yielding	0 — 5	Class H_1
,, ,,	5 —10	,, H_2
,, ,,	10 —20	,, H_3
,, ,,	20 —40	,, H_4
,, ,,	above 40	,, H_5

It is now becoming customary to specify the "class" of optical glass in lists and catalogues, and the optician who uses any particular class knows in a general way what to expect of it in regard to permanence of surface. The requirements of many modern lens designs unfortunately cannot be met without the use of certain types of glass belonging to the lower of the five classes named above, but in such cases care is generally taken to protect their surfaces by using them in positions where they are cemented to other lenses.

The principal physical properties of glass, and the particular requirements relating to them when the glass is to be used for optical purposes, have now been briefly reviewed, and in order to complete our survey we must consider the more definitely "optical" properties of glass. These are the powers of refraction and dispersion which different kinds of glass possess in such varying degrees. In order to facilitate discussion of the optical properties of the various types of glass, it is desirable at the outset to state clearly the quantities or "constants" in terms of which the optical properties of glass are stated. The first and simplest of these is the "Refractive Index." This is almost universally stated as the refractive index measured for yellow or sodium light, as represented by the well-known D line of the spectrum. Usually, in optical literature, this quantity is denoted by the symbol μ_D, and it will be convenient to adopt that notation. The fact that the refractive index has thus to be defined in terms of light of one particular colour or wave-length at once indicates the further well-known fact that the refractive power of glass is different for light of different wave-length. This fact is at once evident when we look at a spectrum produced by allowing a beam of white light to pass through a glass prism. The white light is spread out into the coloured spectrum band, because the rays of each colour undergo refraction (*i.e.* change of direction) to a slightly different extent as they pass through the prism. We can express this by saying that the refractive index of the glass differs for light of different wave-length or colour; so that we have for a given glass not only a constant n_D representing the refractive index for light from the D line of the spectrum, but also a whole series of such constants for every other wave-length of the spectrum. Those which are most frequently used in optical work are n_A, n_C, n_F and $n_{G'}$, where A, C, F, and G′ are spectrum lines usually denoted by those letters. Most of

these (C, F, and G′) are found as bright lines in the spectrum of hydrogen, and it is the ease with which they can be produced which has led to their adoption, in spite of the fact that they are not as well distributed through the visible spectrum as could be wished. When all these refractive indices are known, the entire optical properties of a given glass are specified, and the optician has all the data he requires for his calculations. It is, however, convenient to group these various figures together in certain ways in order to obtain constants which express the optical character of the glass in a readier and more comprehensive manner. Thus, the power of glass to spread white light into a spectrum is termed its "Dispersive Power" or, more shortly, its "dispersion." We define the "mean dispersion" as the width of the spectrum between the lines C and F, and this quantity is measured by the difference between the refractive indices for C and F respectively, thus

$$\text{Mean Dispersion } \Delta = n_F - n_C.$$

We have also to deal with the various "partial dispersions"—which are the differences between the refractive indices for adjacent lines of our system, viz., $n_C - n_A$, $n_F - n_C$ and $n_{G'} - n_F$. And there is one further quantity which it is desirable to define, because it really expresses the properties of the glass in regard to dispersion most concisely—this is the quantity usually denoted by the Greek letter ν; it is obtained by dividing the refractive index, minus one, by the mean dispersion, thus

$$\nu = \frac{n_D - 1}{n_F - n_C}.$$

There is no generally accepted name for this quantity, and it is therefore almost universally spoken of as ν, and by that name it will be best to refer to it in what follows.

Now it is obviously not possible, within the present limits, to enter into the precise manner in which the optician, in designing and calculating his lenses, utilises these optical constants, but if we are to appreciate their meaning and importance from the point of view of technical optics and of the optical instruments upon which so much must depend at the present time, we must follow the matter a little further.

The images produced by the action of simple lenses, *i.e.* by lenses consisting of a single piece of glass ground and polished to simple spherical curves, suffer from a considerable number of defects. If we look at such an image as can be produced by means of an ordinary simple magnifying glass, these defects become very apparent. Most of them are due to what may be termed "geometrical" causes, and they can be corrected by suitable combinations of lenses, provided that glasses of suitable refractive index can be obtained. But there is one defect which is of a somewhat different nature; this is due to the fact that the glass not only refracts the rays of light but also disperses them. The image of a white object is not formed as a single white image, but as a series of partially overlapping images in all the colours of the spectrum. The image is thus slightly blurred and surrounded by a well-marked fringe of colour in the order of the spectrum. Even the lenses of our eyes are not free from this defect, and the coloured fringes can be seen if carefully looked for. This defect is known as "chromatic aberration," and is perhaps the worst of all optical defects. It can, however, be cured to a considerable extent by causing the various coloured images to recombine. If only one kind of glass were available, then the negative lens required to remove the colour fringes would entirely neutralise the original lens, and the combination would behave like a piece of plain parallel glass. But if a second glass is used in which the relation of dispersion to refraction is different from what it is in the first—if, in fact, the two glasses have different values for ν—then the second lens can be made to neutralise the dispersion produced by the first lens, but without entirely neutralising the lens-action of the first. Such a combination is an "achromatic" lens.

We need go no further here than to state the general conclusion that the defects of simple lenses can be to a very large extent corrected by the optician if he has suitable glasses at his disposal; and it is not difficult to realise that the larger the selection and range of the available glasses, the more perfectly is the optician likely to be able to effect his corrections. Now, until the pioneer work of Schott and Abbe at Jena opened the new era in regard to optical glass, the range of optical glasses available for the optician was extremely limited. The older types of glass, known as "crown" and "flint" respectively, afforded a wide range of refractive indices and of ν values, but this range was very much restricted in its usefulness by two circumstances. The first of these is that in these older glasses the values of n_D and ν were rigidly connected by a simple linear relation—in other words, every increase in n_D entailed a corresponding decrease in ν, so that a high refractive index was unavoidably linked with

a large amount of dispersion. One of the great advances effected by the "new" glasses was the provision of types in which high refractive index is combined with low or moderate dispersion (n_D and ν high at the same time). The second and more subtle circumstance was this, that the two types of glasses formerly known—viz., "crown" and "flint"—not only differed in regard to the values of the mean dispersion, but differed in another way when the partial dispersions came to be considered. If we compare the spectrum produced by a prism of hard crown glass with that produced by a dense flint prism, we find first—as the higher dispersion of the flint would lead us to expect—that the second spectrum is very much wider than the first. This difference, however, can be overcome by using a flint prism of different angle, and thus the two spectra can be made to assume identical total width. If now one of them could be reversed and then superposed upon the other, we should at first sight expect them to compensate one another completely and to produce a band of white light. But actually this would not be the case, because if we examine the two spectra more closely we find that the spectrum from the flint glass is considerably more drawn out in the region of the blue and violet, while in the crown-glass spectrum it is the red end which is most widely spread out. If two such spectra are superposed and carefully adjusted, accurate balance can at best be obtained for only two definite places in the spectrum; at all other points a residue of unbalanced colour will be left over—a sort of "residual spectrum." What we have here supposed to occur with two superposed spectra is what actually takes place where crown and flint glass lenses are used together to form an "achromatic" lens. Such a lens can be made truly "achromatic" only for two of the spectrum colours, and residual coloured images remain. If the two corrected colours are well chosen so as to lie in the region of greatest visible brightness, then the residual colours are relatively dark and faint and remain unnoticed in many cases. But where the powers of optical instruments are to be pushed to their utmost limits—as for instance in telescopes and microscopes—these residual colours become very noticeable and militate seriously against the perfect working of the instrument. Accordingly, it is another very important achievement that the newer types of optical glass evolved from the work of Schott and Abbe afford means of finding pairs of glasses in which this difference in the distribution of the dispersion is either entirely absent or very much reduced, as compared with ordinary crowns and flints. This last problem—of finding a pair of perfectly "apochromatic" glasses—as such pairs are called—having a reasonably large difference in their ν values, is not even yet entirely solved, particularly if regard is paid to the other important qualities of glass which have been dealt with in the earlier portions of this lecture.

Without going further into the interesting, but intricate and difficult, subject of lens design and correction, enough has perhaps been said to indicate the nature of the optician's requirements and the extent to which they have been met by modern development in glass production. It will be realised at once that opticians who had at their disposal new materials of such vital importance as the glasses evolved by Schott and Abbe had it in their power to make revolutionary strides in the design and construction of optical instruments. Of this opportunity the German opticians were not slow to avail themselves, and in this way they obtained an advantage which has yet to be fully regained. If we, in turn, can push forward the production of optical glass so as to gain an ascendancy, such a step will bring with it at all events the possibility of gaining a corresponding ascendancy in the production of optical instruments generally. Nor must it be supposed that the mere reproduction in this country of the principal types of "new" optical glass which have been produced and used on the commercial scale in Germany during the past fifteen or twenty years is enough to make up the lee-way. For the scientific knowledge, method, skill and enterprise which made the first advance possible, have not been lying idle meanwhile. Fresh advances have been continually made, and, although not so epoch-making as the first work of the Jena laboratories, they have proved sufficient to maintain the lead originally gained. If we wish to overtake our rivals in this matter, we must first endeavour to attain the real lead in the production of optical glass.

FLOUR-MILLING IN JAPAN.

Flour-milling by machinery in Japan dates back some twenty years—to the formation of the Japan Flour Mill Company—from which date a gradual development is to be noted, despite increasing imports of foreign flour. This development became much more rapid after the Russo-Japanese War, owing largely to the industrial mania which seized

Japan after the close of hostilities and to the raising of the import duty. In a report Consul-General George H. Scidmore, of Yokohama, alludes to this expansion, pointing out that during the *post bellum* period four flour-mills were established in the Kwanto district and three in the Kwansai area, whilst all the companies then established made extensions to their mills. As is so frequently the case, this period of active construction was followed by one of general depression. The new companies formed during 1907 and 1908 were forced to curtail their production almost from the start, because foreign flour was still largely imported on account of depreciation in price, and because of the general economic set-back which affected practically every industry in Japan. These conditions are, however, now rapidly passing away, and there is a good deal of evidence to hand that flour-milling in Japan will again develop, and develop on more conservative and assured lines. For some time past the price of flour has appreciated practically throughout the world, and whilst the supply of domestic flour is ample, perhaps, for her home demand, Japan is able steadily to build up her exports of this commodity. For many years Japan has exported flour to China and Chosen, and, granting all possible progress to the milling industry in China, China must for some years to come be an increasingly important purchaser of flour from abroad, and no country is better situated or more alive to her requirements than Japan.

INDIAN MINERAL INDUSTRIES.

Speaking at the annual meeting of the Mining and Geological Institute of India, Mr. H. H. Hayden, the president, discussed the steps being taken to enable India to profit by the new conditions established by the war in the mineral industries of the world. The wolfram output of Burma is being expanded, the tungsten industry has been taken out of German hands, and a new British industry has been established. Prices for wolfram ore of the average quality which Burma can produce now range from £180 to £190 per ton as against £100 before the war, and thus every inducement exists for larger production. The measures taken by Sir Harcourt Butler in Burma to expand the production of the mines in Tavoy, now one of the chief producing districts of the world, have not yet become fully operative, but it is believed that from four to five thousand tons of the ore will eventually be won annually. The point has to be considered whether this industry can be placed on such a permanent footing that it will not suffer when prices drop after the war, and the excessive demand for high-speed tools in connection with the manufacture of armaments ceases to exist. Mr. Hayden considers that if the industry is now placed on a sound foundation it will be able hereafter to survive the competition which will come from Portugal, the United States, and parts of South America. The present high price of the ore, he says, offers a favourable opportunity for development to be carried out in the most efficient manner, and those mines that now take advantage of this will be in the best position afterwards to keep their cost of production within a figure that will enable them to compete with producers in other parts of the world. The suggestion is made that it would pay to make ferro-tungsten on the spot if the electrical method can be economically introduced into Tavoy. If this is not possible, the wolfram ore might be carried to the neighbourhood of the Bengal coal-fields, there to be heated by the reverberatory furnace method with cheap fuel available in abundance. India must always be at a disadvantage as regards cost of carriage, and hence the proposal to export the finished or partially finished product instead of the raw material. The suggestion is one well worth considering, as every effort should be made to prevent a collapse when normal prices are re-established. In respect of manganese ore, Dr. Fermor has shown that the manufacture of ferro-manganese may be regarded as a sound commercial proposition. If then India can arrange for the partially finished product to be exported instead of the ores, the wolfram and manganese industries should be assured of that permanence which is so desirable. Mr. Hayden touched also upon the question of coal-tar dyes, the manufacture of which in India does not seem promising, and upon the glass industry, which he regards very hopefully, especially in the matter of the supply of glass bangles. The outturn of sulphate of ammonia could also be expanded for use in artificial manures, though a large trade in these is not in view. The production of aluminium on a big scale would only pay if an outlet outside India could be found.

INCREASE IN CHINA'S LEATHER IMPORTS.

The importation of leather and leather manufactures into China, according to the U.S. Vice-Consul of Shanghai, has steadily increased in recent years.

Among the reasons for this were the purchases of new equipment for China's army, including boots, shoes, belts, etc.; the establishment of cotton, silk, and flour mills, which has created a demand for belting; and the adoption of the Western style of dress by many of the Chinese, with incidental purchases of shoes, trunks, bags, and other articles. Although a few tanneries have been established in the coast and principal cities, and, to some extent, in the interior (one of some importance in Szechuan Province), they have not been, thus far, very successfully operated. Various causes are responsible for this condition, poor business management and a lack of proper technical knowledge of the trade being predominant. There are indications that China will continue to have a great part of its leather needs supplied from abroad for some time.

A large proportion of the leather imported into China is transhipped at Hong-Kong, and it is therefore impossible to ascertain its origin from the Chinese maritime customs statistics. Undoubtedly the greater part of it comes from Singapore, and the remainder from various European countries. Japan's share of the trade is also very large, particularly in leather manufactures. Its proximity to China, the low cost of production, and the opportunity for prompt deliveries, are largely responsible for this condition. The inferior quality of the Japanese product is advantageous, for the Chinese almost invariably consider price before quality. In fact, Japanese competition is not a factor in the higher grades.

There has been considerable trade in boots and shoes. China imported in 1914, 227,174 pairs, valued at $392,819. Of this amount 65·8 per cent. came from Russia, 11·21 per cent. from Japan, 7·55 per cent. from the United Kingdom, 7·46 per cent. from the United States, and 4·2 per cent. from Hong-Kong. The importations of boots and shoes into Shanghai during 1914 were 37,695 pairs, valued at $69,680.

BLIGHT-PROOF COFFEE FOR THE PHILIPPINES.

When, twenty-five years ago, the coffee blight, which was then sweeping over the entire East, visited the Philippines, it destroyed, so far as production for export was concerned, a formerly flourishing industry; and since that time the cultivation of coffee in the islands has been confined to one or two mountainous districts, where the altitude was sufficient to exclude the blight. In these localities almost every house has had its coffee patch, and on them, despite careless methods of cultivation, an excellent quality has been grown. The quantity of this product has been inconsiderable, however, from a commercial point of view, and coffee has never again taken a place of any importance in the list of Philippine exports. There has never seemed, however, any conclusive reason why a blight-proof stock should not be successfully introduced, as had been done in Java and Ceylon, with the result of rehabilitating the coffee industry of those countries to a great extent, though they had originally been almost as hard hit as the Philippines. According to the *Manila Daily Bulletin*, experiments with this end in view have been somewhat numerous, and not long ago it was announced that measures would be taken to import a supply of the *robusta* variety of coffee plants for distribution. For some time, however, it proved impossible to secure satisfactory stock in sufficient quantities; and it has only lately been announced that, as a result of negotiations with the Dutch Indian Government, a supply has at last been assured from Java. The chief of the plant-breeding station at Buitenzorg has undertaken to send 200 lb. of selected varieties, and it may be that this will mark a definite beginning of the work of putting on its feet again an industry which at one time made a good many fortunes in the Philippines.

DETERMINATION OF BARIUM COMPOUNDS IN RUBBER GOODS.

Specifications for purchasing rubber goods frequently permit the use of barytes (barium sulphate) as a mineral filler without having the sulphur which it contains count as part of the specified total sulphur. In such cases the barium sulphate must be determined in order properly to correct the total sulphur.

When barium sulphate only is used, the amount present is readily ascertained by determining the total amount of barium present. If barium carbonate is used, it is necessary to separate the two salts. By means of tests made on compounds of known composition prepared at the United States Bureau of Standards, a method has been devised which permits the quantitative determination of barium carbonate in the presence of either lead sulphate or barium sulphate, the two sulphates most commonly used in rubber goods. The accuracy of the determination is satisfactory for all practical purposes.

These tests are described in Technologic Paper No. 64, "The Determination of Barium Carbonate and Barium Sulphate in Vulcanised Rubber Goods," which may be obtained by interested persons from the Bureau of Standards, Washington, D.C.

FISH-CULTURE SERVICE IN THE UNITED STATES.

Preliminary data gathered by the United States Bureau of Fisheries establish the fact that a new record has been set in the output of the Federal fish hatcheries. This has exceeded 4,300,000,000, or about 250,000,000 more than in 1914. The Bureau calls this a normal healthy growth, representing increased activity and efficiency in the various fields. "This very satisfactory result," it says, "has been accomplished without material increase in appropriation, and has depended largely on the faithful execution of carefully-laid plans by the hatchery officials and their assistants."

During the year the production of the commercial food fishes of the interior and coastal waters, and of the basses and trouts which, while classed as game fish, nevertheless enter largely into the food supply, has been augmented.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Manufacturers and Scientific Teaching.—Appreciable headway begins to be made in the promotion of scientific research into the problems of the textile industry. In the West Riding funds have begun to flow for a scheme which includes the endowment of research and the foundation of numerous scholarships, and involves incidentally a new alignment of the textile schools in the county. The initiative comes from the University of Leeds, the county

and borough education authorities co-operating, and the most influential manufacturers throughout the area have been already won over. The heads of some of the greatest industrial organisations in the world attended the recent meeting at Wakefield, cheerfully giving up time that is supremely valuable at present and exhibiting every symptom of enthusiasm and unanimity in the liberal ideas propounded by the speakers. In terms of money the object is to raise £5,000 a year for five years by the contribution of some hundreds of subscribers whose subscriptions are to form a new bond of interest between them and the schools. The object will not be fully achieved unless large numbers of manufacturers become contributors of advice and suggestion, and in an entirely new degree make the schools their own. There are at any rate good prospects of a closer partnership and the efforts made can be no other than beneficial.

A Standard Technical Course.—A re-organisation of local textile schools in an area where they are somewhat numerous is necessary for economy and efficiency, and it is clearly advisable that the schools which cannot advantageously give a five years' course should cease to attempt to do so and confine themselves to a two-years' course. Two years' technical training combined with the study of modern languages is a curriculum recommended for commercial travellers. Two years with art training is advocated for designers, and the same two years with other special training for other specialists. The Yorkshire scheme has many features to recommend it in the eyes of manufacturers who are accustomed to standardisation and to the bulking of all requirements. The plan being good it remains only to be seen that the preliminary two years' course is the right one, given by teachers of the requisite gifts and attainments, and in time the standard of teaching can probably be more easily raised under the scheme than under the somewhat chaotic conditions which have hitherto prevailed.

Current Textile Research.—The co-ordination of schooling involves the transference of the most promising students to central institutions and thereby leads to the prosecution of research in premises suitably staffed and equipped. In the West Riding, at Leeds, Huddersfield and Bradford, certain researches in colour chemistry are well under way and others are in project. At Leeds, with the co-operation of physicists, research directed towards the electrification of fibres is proceeding, and there is room to relieve spinners of a considerable burden by the application of new knowledge to an old and obscure problem. At Leeds also, research is being pushed into the colloidal nature of the wool fibre, and explanations of familiar phenomena may be expected from it—if no more. For the rest, those who are wishful to undertake specific researches are waiting to hear what it is that the manufacturer most wants to know. It has been suggested that useful research might be conducted upon certain conditions in the works of manufacturers who find themselves confronted with a technical difficulty. A final decision has not been reached, but the committee acting in the West Riding contemplates an arrangement which would leave new discoveries private to individual manufacturers for a time.

Research upon Silk.—Meantime, the Silk Association of Great Britain and Ireland has tabled an articulate scheme of research for which funds are being sought from all parties concerned with British silk. The object is of interest to all sections alike, and may most shortly be described as a research into the causes of defective brightness of finished result. Raw silk is composed both of soluble and insoluble constituents, and the investigation proposed deals with the chemical composition of those constituents which are suspected of creating difficulties in "de-gumming," dyeing and finishing and of setting up detrimental subsequent changes in silk manufactured goods. It is proposed to carry on the laboratory work at the Imperial College of Science and Technology and simultaneously to obtain practical confirmation of the results by observations made within industrial premises. It is proposed that the findings shall be reserved to members and contributors for a length of time to be determined by the Advisory Council for Scientific and Industrial Research. Of the £1,000 to be expended in the next two years members of the silk trade are invited to contribute £400, the balance coming from the Government grant. There is no industrial user of silk to whom these experiments are not important, and the conditions afford a complete guarantee of the best employment of the money. This modern effort for the advantage of the silk industry recalls certain earlier ones made by the Society. An attempt to establish the culture of silkworms in this country had to be abandoned by the Society in favour of a not very productive encouragement of sericulture in Carolina and Mauritius. The name of the Society is linked with certain improvements in the Jacquard loom which, one hundred years ago, was more exclusively a silk loom than it now is.

The Matter of Holidays.—Official representations have not been quite successful in inducing textile workers and employers to forego or rearrange the usual summer holidays. The holiday week which is looked to, and saved against, for the whole of the rest of the year

represents a great deal to the textile operative. Particularly in Lancashire the week forms a very large slice of the amenities of life. To employers the week in which the mill is stopped gives a necessary opportunity of effecting repairs which cannot be made with the engines running. The batch system of holiday by relays is not seriously practicable in the spinning industry, although some weaving manufacturers are practising it this year. The annual holidays fixed in the summer are made to correspond generally with the slack season in trade, and thus the normal timing is doubly advantageous. Any other period for holiday taking would be less convenient for all parties, and although it is possible that a better occasion will present itself to the tired munition workers, it is not certain that the pressure upon some classes of textile operatives will relax. The more the circumstances are understood the more it appears that manufacturers have generally been doing the best that they can even where official advice seems to have been discounted.

The German Industry.—The United States Consul at Breslau, in an address delivered in Philadelphia, affirms that since March 1915 German imports of American raw cotton have practically ceased, and that every available pound has been consumed. Mr. Seltzer adds that the rags of cotton piece goods are being torn up to be respun and rewoven into materials for military purposes. The statement that German mills are able to run something less than half-time points to the receipt of raw cotton, probably from Turkey. The speaker exerted himself to deny the possibility of an influx of cheap German manufactured cottons in the period immediately following the war, and upon this point the position in respect of raw material is not the only one to be considered. Mr. Seltzer declares that labour is dear and scarce at present, and holds that the days of German cheap labour are gone. The opinion is interesting, if more speculative than the assurance that after the war the foremost need of the German textile industries will be more capital and large supplies of raw material. American hosiery manufacturers were adjured to "put in more boilers, more steam, more enthusiasm and more salesmen." While the German textile industries will, as a whole, need more capital, it has to be recalled that good profits are being made by the concerns doing Government work. It is conceivable that the days of cheap labour have gone as conclusively from some other manufacturing countries as from Germany. Certainly in this country employers do not see how the prevailing high wages can be readily reduced, and are more actively concerned to see that the rates are earned than that they are pulled down.

GENERAL NOTES.

The Future of German Railways.—The Germans are laying countless plans and forming countless projects for the period "after the war." They are even discussing utilising the special war rolling-stock, of which they and the Austrian railways now possess so much, for commercial purposes after the war. For example, the ambulance trains, infection trains, hospital trains, kitchen trains, provision trains, carriages for consumptives, ammunition waggons, etc., are all to be put to some use or other. The bath and disinfection trains, it is suggested, by means of which 2,400 soldiers can have a bath and have their clothes disinfected and cleansed in a single day, might be very suitable, with perhaps but little modification, for long distance *trains de luxe*—at any rate the bath compartments might. It is pointed out that passengers able to travel by these trains would willingly pay extra for bath tickets, the expense of the bath compartments being thus easily recouped.—*The Engineer.*

Electric Power Production at Chicago.—In an article recently published in the *Electrical World*, Mr. L. A. Ferguson describes the development of power-station practice at Chicago. In the early days there were more than twenty-five separate generating stations, the fuel consumption per kilowatt here being 10 to 15 lb. of coal in the smaller and perhaps 6 lb. in the larger and better-equipped stations. The Fisk station was opened in 1903 with three 5,000-kw. units, the coal consumption of which was 115 per cent. more than that of the modern units recently installed. The cost per unit was also greater by the same amount, whilst the cost of attendance was 170 per cent. more. Moreover, in the thirteen years which have elapsed since the station was opened the cubic capacity occupied per rated kilowatt has diminished from 146·5 cubic ft. per kilowatt to 31·3 cubic ft.

Standard Tables for Petroleum Oils.—Samples of petroleum oils have been collected from different parts of the country by the United States Bureau of Standards, and the specific gravity determined over a wide range of temperature. From the data obtained tables have been prepared for determining the true specific gravity and volume of oil at the standard temperature, when these quantities are measured at other temperatures. Tables have also been prepared for showing the relation between specific gravity, Baumé degrees, and pounds per gallon. The new tables will be especially useful in determining the quantity of oil in large shipments. These will very largely supersede the privately issued oil tables heretofore used. Circular No. 57 of the Bureau of Standards presents the results of these experiments, and copies may be obtained by interested persons from that Bureau at Washington.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

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EXAMINATIONS.

The results of the Advanced (Stage III.) Examinations, held from May 29th to June 7th last, were posted to the centres concerned on the 2nd inst.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

OPTICAL GLASS.

By Walter Rosenhain, D.Sc., F.R.S.,
Superintendent, Metallurgy Department, National Physical Laboratory.

Lecture II.—Delivered December 6th, 1915.

In the present lecture I propose to describe the process of manufacture by which the optical glass obtainable at the present time is produced. Before doing this, it would be interesting and instructive to follow up the entire history of this particular process and to consider the various steps in the achievements of optical glass makers. This would be the more interesting because this very business of producing satisfactory optical glass—particularly in large blocks or discs—has attracted the attention of many of the greatest men of science, including such names as Fraunhofer, Faraday, Arago, Dumas, Harcourt, and Stokes. But we are primarily concerned with the present-day process and its problems, and the hopes for future improvement, so that we cannot dwell on the historical aspect. It must therefore be sufficient to say that the fundamental discovery in regard to the production of optical glass was made, not by a practised glass-maker, but by a Swiss watchmaker, named Pierre-Louis Guinand, who about 1790 found that by continued stirring of the molten glass it was possible to remove the veins and striae which render ordinary glass useless for optical purposes. Guinand's process was taken up, through the influence of a statesman named Ützschneider, in Bavaria, and Fraunhofer

became associated with it. It is interesting to note that Fraunhofer's discovery of the dark lines in the solar spectrum was rendered possible by the fact that he possessed prisms and lenses made of optical glass which had not up to that time been available to other workers. We have in this a striking example of the way in which progress in optical glass at once opens the way for unexpected progress in other directions.

The process introduced into Bavaria by P.-L. Guinand was further developed in Bavaria by his eldest son, while the second son, Henri, took the secret to Paris and endeavoured to establish the industry there in conjunction with Bontemps, who was then director of the glass-works of Choisy-le-Roi. Their joint work did not prosper and the partnership was soon given up, but Bontemps carried the work to success. In 1848 political troubles caused Bontemps to leave Choisy-le-Roi and to join the glass-works of Messrs. Chance Bros. at Birmingham, where a very successful optical glass industry was at that time established. Meanwhile Henri Guinand developed the industry in Paris, at first in a very small way; these works, however, developed and became famous for their products under Feil, the grandson of H. Guinand. Feil has in turn been succeeded by Mantois and later by Parra-Mantois. Meanwhile, however, other efforts had been made, in England and elsewhere. Here we may mention first the prizes for optical glass offered by this Society of Arts as early as 1768 and awarded in 1770 and 1771, and then the work of Faraday, under the auspices of a Committee of the Royal Astronomical Society. Faraday came to the conclusion that the problem of producing optical glass of good quality was a mechanical and not a chemical one, and he succeeded, by exceptional skill, in making satisfactory blocks of a very dense lead-borate glass—known as the "heavy glass" of Faraday. This glass, however, suffered from great lack of durability, and there-ore had to be abandoned for practical purposes. Subsequently Harcourt made numerous experiments in glass-melting, and Stokes and John Hopkinson also interested themselves in the subject.

No very considerable advance was, however, made until Schott and Abbe undertook their great pioneering work at Jena. Up to that time, the materials used in glass-making were very few in number, including only silica, lime, soda, potash, and lead. It is the great merit of Abbe to have realised that these limitations of material must be left behind, and to have suggested a systematic study of the elements with a view to ascertaining which of them could enter into glass and what would be the effect of each.

Aided by liberal grants from the Government, Schott and Abbe were not only able to carry out their investigations, but to translate their results into industrial practice. Far-reaching as the results of their work have been, however, it must be noted that they worked primarily on the materials of the glass itself, and not on the means of producing optical glass. Certain modifications and improvements they undoubtedly introduced—particularly in regard to annealing—but the general method of making optical glass at the present time, whether at Jena or elsewhere, still remains essentially the method of Guinand.

Our survey of this aspect of our subject will be rendered easier if it is stated at once that the "method of Guinand" consists first in the systematic stirring of the molten glass in order to remove the striae, and next in allowing the glass, after completed stirring, to remain at rest in the melting-pot so as to solidify without any disturbances which might again introduce striae. Each melting of glass thus involves the sacrifice of a melting-pot, and occupies a very considerable time.

We will begin the detailed account of the present-day method of optical glass-making by a consideration of the raw materials which are employed. The key-note to this aspect of the matter is contained in the one word "purity." There is probably no other branch of industry in which slight traces of impurity are liable to produce such serious ill effects. Chemical analysis of the finished glass can scarcely serve as a guide to the limiting amounts of various impurities which can be permitted in optical glass: the reason is that there is probably no chemical test for detecting the presence of impurities like iron or sulphur which is so sensitive as the "colour test" in glass itself. As we have seen in the previous lecture, a very faint tinge of colour, which is quite invisible in small pieces of glass, becomes very obvious when large thicknesses are examined—and this method of examination undoubtedly allows of the detection of quantities of colouring impurity which pass utterly undetected by other chemical means, with perhaps the exception of the spectroscope. Even in a fairly deeply-coloured glass of the dense barium type, the analytical determination of the iron or sulphur present is extremely difficult. Since, in the case of iron,

at all events, "what goes into the pot comes out again," it follows that extreme care is required to avoid the entry of iron into the mixture. Further, since the pot or crucible in which the glass is melted is partially dissolved, the iron-contents of the fireclay of which the pot is made are also of importance. So extreme is the need for specially pure materials that for certain kinds of optical glass the glass-makers themselves are obliged to undertake the further purification of chemicals which are purchased as "pure."

The most important of all the raw materials is undoubtedly sand, which serves as the source of the silica present in the glass. As many glasses contain well over 70 per cent. of silica (SiO_2) the importance of this material is obvious. In this respect glass-makers in England are unfavourably situated, since there are at present no very suitable sands available in this country. Whether exhaustive search might lead to the discovery of a suitable deposit is doubtful, because a large number of firms have already sought for good glass-making sands, and find it difficult to supply even the requirements for ordinary window (sheet) glass. The sand employed for optical glass has therefore to be imported into England; at present it is obtained from Fontainebleau, near Paris, where an extremely pure sand is obtainable. Germany is fortunate in possessing several good sources of pure sand, one of them being probably the purest yet found—it shows a silica-content of 99·98 per cent. This necessity of importing at considerable expense that material which constitutes the greatest proportion of optical glass involves a commercial disadvantage to British industry in this direction, and still leaves us dependent, in a vital matter, on a source outside the King's dominions. A systematic search in various parts of the British Empire would, however, be certain to reveal a source of really pure sand suitable for this purpose, and if the cost and difficulty of transport were not unduly great, this might solve the problem.

While chemical purity is the most vital necessity in regard to sand as a raw material for optical glass, it is not the only point to be considered. The character of the grain is also of importance. In this respect, uniformity of grain is the chief essential, since it allows a uniform rate of melting throughout the charge. If there are a few large grains among a mass of finer ones, these large particles are apt to remain undissolved when the rest have melted—and this leads to serious defects in the glass.

Passing on to other materials, we find that the various glass-forming substances are introduced into the mixture, or "batch," in various forms, but principally in the form of carbonates. Thus lime, magnesia, soda, potash and barium are generally employed in the form of carbonates. Sometimes hydrates are used, such as boric acid, alumina, and sometimes lime (in the form of slaked lime). In some cases it is possible to use the oxide—as in the cases of lead and zinc. Finally, for the purpose of introducing strong oxidising agents into the mixture, some substances are employed in the form of nitrates—principally saltpetre (potassium nitrate) and nitre (sodium nitrate), and, in some cases, barium nitrate. Glass-makers attach a good deal of importance to the proper "balance" of these various substances, and there is some little justification for their views, since the volume of gases which are evolved during melting, and the precise period when they are given off, must depend upon the form in which the ingredients of the mixture are introduced. Another circumstance which is affected by this selection is the extent to which the mixture will froth during the early stages of melting; since this factor governs the rate at which the pot can be filled, it is of considerable practical importance.

In all these materials, extreme purity and a state of uniformly fine division are the essential features. In the manufacture of ordinary glass, particularly in tank furnaces and in open pots, it is usually found undesirable to use materials in a very fine state of division—principally on the ground that the very fine particles are apt to be blown away by the draught of the furnace. In optical work, however, this consideration does not arise, because covered pots are used, and the materials are not exposed to draught. From the point of view of rapidity and ease of melting, there can be no doubt that extremely fine division of the materials, coupled with very intimate mixing, is a considerable advantage.

As an illustration of the kind of meticulous care which is required in the production of optical glass, another point may be mentioned. Some materials—notably potassium carbonate and sand—are apt to absorb a certain amount of moisture, and their moisture-content tends to vary appreciably with atmospheric conditions. Consequently, the amount of actual silica (SiO_2) which is introduced into the mixture by weighing out 100 lbs. of sand will depend upon the exact state of moisture of the sand at the

moment of weighing out. If accurate results are aimed at, a determination of the moisture must be made each time and a correction applied to the weight used.

Since optical glass mixtures are generally required in relatively small quantities, they are weighed out and mixed by hand. The latter process is a very unpleasant one, in consequence of the irritating dust which arises. Very intimate mixing is desirable, and it therefore seems probable that mechanical mixing would afford considerable advantages, provided that it could be done without risk of introducing iron into the mixture.

Whenever possible, the mixture of raw materials receives an addition of "cullet"—*i.e.* of broken pieces of the same kind of glass as that which it is desired to produce. The presence of this "cullet" is useful, not only as utilising what would otherwise be waste glass from previous meltings, but also in facilitating the fusion of the new batch. The action is due to the fact that the finished glass is more fusible than its ingredients, and that when these pieces of glass melt they dissolve up the adjacent materials and assist them to come together. It is, however, perfectly possible to make satisfactory glass without the use of "cullet," and indeed this has frequently to be done in practice.

We have now to consider the process of converting the "batch" or mixture of raw materials into glass by melting it in a suitable furnace. The type of furnace used for the production of optical glass differs in certain essential features from those used for producing other kinds of glass. In order to understand the causes of this difference we may recall that in ordinary glass-furnaces of the "pot" type, a number of pots or crucibles containing either identical glass or at least glasses of closely similar type are heated together. As the contents of all the pots behave in a closely similar manner, it is possible to work with a considerable number, ranging from four to as many as twenty-four, without any great difficulty. In the case of optical glass, such an arrangement is impossible, for several reasons—each pot of glass requires its own special treatment in regard to time and temperature of heating, etc.—so that it becomes essential to have only one or at most two pots in the furnace at one time. Not only this, but the amount of skilled attention which each pot requires is so great that one "furnace crew" could hardly deal with more than two pots. Further, in ordinary glass-making it is the aim of the glass-maker to adopt a mixture which will melt and "fine" well, so as not to put any excessive strain on the furnace, either as regards temperature or duration of heating; in fact, the glass is adjusted so as to work nicely in the furnace. In the case of optical glass, on the contrary, no such adjustment is possible; the composition of the glass is fixed by the requirements of the optical properties, and the furnace must be worked and regulated so as to suit the glass. Finally, in ordinary glass-making the pots and furnace are worked in so-called "journeys" (from the French "journée")—the pots are filled with raw material, the glass is melted and fined and then it is taken out of the pots while still liquid, either by being gathered on the pipes of the glass-blowers or by being taken out in ladles. This whole cycle of operations may occupy a period of from 20 to 30 hours, and is then repeated; it is only for a few hours during the "fining" process that the furnace attains its maximum temperature. The pot itself remains in the furnace for a whole series of such operations—sometimes for as long as 10 or even 20 weeks. In the case of optical glass, on the other hand, a new pot is required for each melting, while the melting itself occupies from three to four days, during which the furnace may be exposed to its maximum temperature for 18 or even 24 hours on end. It will be seen at once that the furnace requirements are widely different from those for ordinary glass-making. Facility for inserting and removing the pots is one important requirement, and facility of regulation, together with the power of maintaining very high temperatures for prolonged periods, is also essential.

The actual furnaces used for this work are, however, of a surprisingly simple character. The older type, which remained in use in this country until a few years ago, was heated by a direct coal fire, maintained on a very large deep grate and under strong draught. A section of one of these furnaces, showing the pot and the stirring apparatus in position, is given in Fig. 3. It will be seen that the pot stands in the centre of a fire-brick chamber, with the two large deep grates on either side of it; the products of combustion leave this furnace chamber through a number of small openings by which they escape into an outer conical space which acts as chimney. This simple—almost primitive—type of furnace has, of course, many obvious disadvantages: it is uneconomical of fuel and requires specially expensive fuel (large picked coal); it is laborious to work, since the

coal must be shovelled on by hand and the grate must be freed from clinker—also by hand—at intervals, while during these intervals the temperature of the furnace is liable to drop dangerously. Modern practice has therefore replaced these coal-fired furnaces by those of

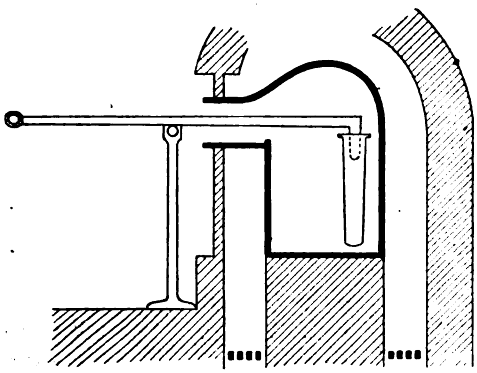

Fig. 3.

Sectional Diagram of Optical Glass Furnace (Old Coal-fired Type), showing the covered pot and stirring apparatus in position.

the regenerative gas-fired type. These are exactly similar to other gas-fired furnaces except that they are small and are built to work with either one or two pots, and of such a shape that the pots can be readily inserted and removed through a wall of false-work at the back of the furnace. Glass-makers always prefer to have what they term a "bottom-heat" in their furnaces, and these are accordingly arranged so that the flame plays principally about the lower portions of the pots. This secures that melting shall begin, as far as possible, from the bottom of the mixture; in the contrary case, if the surface layers melted first, the molten surface layer would cover over the unmelted lower portions and very much retard their fusion and hinder the escape of the gases evolved during fusion.

In addition to the melting furnace itself, a number of subsidiary furnaces are required for optical glass production, but it will be convenient to refer to these in connection with the various operations. We have, however, to consider a very important factor in the whole process—viz., the pot or crucible in which the glass is melted.

The pots employed for optical glass production are somewhat similar to those used in flint-glass manufacture, but usually somewhat smaller. They are known as "covered" pots, because the crucible or pot proper is covered over by a dome-shaped upper portion which is formed at one side into a neck; this neck is so placed as to project through an opening in the wall of the furnace, and through this neck the raw materials are introduced and all manipulations are carried out. The shape is illustrated by a vertical section taken through the neck, which is seen in Fig. 3, and by a perspective sketch in Fig. 4. The size employed is the largest which can be conveniently handled in a given works, since it is advantageous in every way to use a large pot; the limitation arises, however, from the great weight of the pot when full of glass, for—as we shall see presently—the full pot has to be taken out of the furnace while hot. In practice, pots measuring from 24 ins. to 40 ins. in diameter are employed.

The production of these large domed vessels is a matter which requires considerable skill and care. The first point is the choice and preparation of the fireclay out of which the pot is to be made. This point will be more fully dealt with in the third lecture, and here we need only dwell on the care required throughout the whole process. The clay itself must be properly "matured" by prolonged keeping in the damp and the dark. This maturing of clay is a well-established phenomenon which was known to the ancient Chinese potters, who handed down their wet clay "bodies" from father to son as a most precious possession, only using them after long years—or even centuries—of storage. Modern investigation has indicated that the action is largely bacterial—in fact, attempts have been made to grow cultures of special

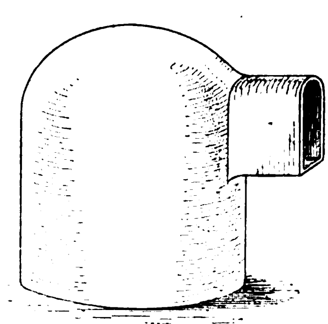

Fig. 4.

Covered Pot used for Melting Optical Glass.

clay-maturing bacteria. That an evil ammoniacal smell is produced is quite certain. It has also been found that an addition of certain colloidal substances, such as gallic or tannic acid, produces similar improved properties. We need not, however, pursue this subject—

enough has been said to indicate that there is a good deal more in this matter of "pot clay" than appears on the surface.

The actual making of the pot is necessarily a somewhat gradual process. The thick lower portions are sometimes formed in a wooden mould, but this part of the pot must be allowed to dry sufficiently to become fairly hard before the upper portion is added—otherwise the weight of the upper portion would push the lower part out of shape. On the other hand, if the lower portion is allowed to get too dry, the upper portion will not adhere properly, or there may be too great a difference of shrinkage and one part may crack. Finally, when the pot is completed—after a process extending over something like four months—it must be very slowly and steadily dried by prolonged storage in rooms whose temperature and moisture must be carefully regulated. This drying process generally occupies a further period of four months, although glass-makers usually feel safer in using pots which have "matured" for at least six months.

When the finished pot—now "air dry"—is to be used, it is taken with very great care, since it is very weak and fragile, from the drying-room to the furnace-room. But the "green" pot in this condition cannot be placed directly in the hot melting furnace. If this were to be attempted, the pot would fly to pieces immediately. This is due to the fact that the dry clay still contains water in a state of loose chemical combination known as "hydration," *i.e.* the silicate of alumina of which the clay consists is still chemically combined with a considerable amount of water. The pot must, therefore, be heated very slowly and gently until this water of hydration is driven off. At that stage, however, the clay is extremely friable, since the water acts to a large extent as the binding medium in the "green" clay. When the clay has been strongly burnt, on the other hand, it is held together by a cementing medium which arises from the very first beginnings of fusion or melting in the clay itself. In the intermediate stage, when the water has been driven off but this incipient melting has not yet been reached, the clay is left very weak and friable. As a result of these properties of clay, the heating-up or burning of a large thick vessel like the optical glass pot is a matter requiring great care in regulating the temperature of the kiln or furnace in which the operation is conducted. The operation consists in raising the temperature of the chamber in which the green pots are placed slowly and steadily up to about 900° C. (a bright red heat), but this must be done without allowing a single tongue of flame to lick the pot before it has attained a dull red heat. If such an accident occurs—or if the kiln is heated too quickly, or if a cold draught is allowed to play upon the pot—then a crack is certain to result. Such a crack is not always at once apparent, but it becomes only too obvious when the pot is placed in the melting furnace. Even a slight crack is a fatal defect, as it is almost certain to open out during the fierce heating at the later stages of the process. Consequently, if a crack is seen, the pot is usually rejected as useless.

When the pot in its kiln or "pot arch" has attained a bright red heat, it is ready to be transferred to the furnace proper. The furnace is opened and allowed to cool until its temperature is nearly the same as that of the pot arch; then the doors of the latter are thrown open and the pot is taken out. The heavy red-hot pot is handled for this purpose by being picked up on a great fork with a long heavy iron handle; this fork rests on an axle which is carried by two small stout wheels. The prongs or "tynes" of the fork are placed under the pot and the handle is depressed until the pot is lifted up on the fork. Then the whole is wheeled up to the furnace and the pot is deposited in the furnace in its proper position. The "false wall" of the furnace is rapidly built up by workmen protected from the heat by thick felt or asbestos "armour," and then the temperature of the furnace is gradually raised. It is at this stage, when the outside of the empty pot is necessarily hotter than the inside, that cracks generally open out and become readily visible. If such a calamity is avoided, however, the furnace and pot in a few hours attain the temperature required for commencing the melting process.

The first step is that of "glazing" the inside surface of the pot. For this purpose a small quantity of cullet, of the same kind of glass as that which is to be produced, is thrown into the pot and allowed to melt. Then, with a suitably-shaped iron rod, this small quantity of molten glass is smeared all over the walls of the pot in order to coat it with a thin layer of glass. The object of this glazing operation is to protect the walls of the pot from the chemical action of the raw materials which are next introduced into it. Since the glass contains the various ingredients in a more or less "balanced" form it is usually less violently

active in a chemical sense than some of the raw materials. To this extent the "glazing" serves to protect the pot.

The next stage is that of introducing into the pot the raw materials or "batch," whose nature and preparation we have already considered. The pot can only be filled by stages, since the raw mixture not only occupies much more space than the molten glass, but also the very heavy evolution of gases from the melting material causes it to "froth" very strongly. The quantity of mixture introduced at one time is, in fact, governed by the consideration that it shall not "boil over" to any serious extent. Thus the filling of the pot can only be accomplished in many stages—from six to eight or ten. When the whole of the "batch" has been filled into the pot, the glass should just slightly overflow the lip of the pot, in order to allow the slightly impure surface layer to be easily removed or "skimmed" off.

Then the "fining" process begins. At this point the glass, although completely melted, is still full of bubbles of gas. These arise partly from air which has been enclosed in the melting glass, but to a much greater extent they are derived from gases evolved during the chemical reactions which accompany the fusion of the glass. Carbonates, nitrates, hydrates are all decomposed, and give off their carbonic acid and water and nitric oxides as heated gases. To remove these bubbles the glass is heated until it becomes thoroughly fluid or "thin," so as to allow the bubbles to rise to the surface. When the bubbles are large this occurs very readily and the glass is said to "fine" easily. In fact what the glass-maker most desires is to see the glass "boil" well. If on the other hand the bubbles are very fine and numerous, it becomes extremely difficult and in some cases impossible to remove them. Here again optical glass presents a problem of much greater difficulty than that met with in ordinary glass making, for while in the latter the exact composition can be varied in order to produce a mixture which evolves large bubbles or "boils" well, such an adjustment is not possible in the case of optical glass, for the reason that the chemical composition of the glass itself is definitely fixed by the optical requirements, so that no very considerable variations in the mixture are possible. Such variations are, in fact, confined to changes in the exact form in which the various elements are introduced—whether as hydrates, carbonates, nitrates, etc.—and this variation alone is not always adequate to make the glass behave in a satisfactory manner during "fining." There are other difficulties also to be faced; with most commercial varieties of glass the fining can be accelerated by pushing the furnace to its extreme limit of temperature, the glass becoming increasingly fluid as it gets hotter. This, of course, also applies to optical glass, but there are two serious limitations. Very high temperatures tend to change the chemical composition of glass, owing to an appreciable loss of certain constituents by volatilization. Where the chemical composition is so important from the point of view of attaining exactly the desired optical constants, these changes are liable to be of serious importance. In some kinds of glass, moreover, the temperature must not be raised beyond a very definite limit, as higher temperatures result in spoiling the colour of the glass—perhaps by increased action on the pot or by chemical reaction with the furnace gases diffusing through the walls of the pot. These special difficulties in connection with the "fining" of certain kinds of optical glass are now so well recognised that whole series of optical glasses are habitually accepted and employed while contaminated with a very obvious sprinkling of very fine gas-bubbles. These are, fortunately, quite harmless from the optical point of view, merely scattering a very minute proportion of the light, but without interfering with the definition of the images.

The completion of the "fining" process is determined by means of samples or "proofs" taken from the surface of the molten glass. In some works these are merely the sheaths of glass which solidify on a flat iron rod which is passed into the glass, but in other works a little of the glass is gathered on a small glass-blower's pipe and blown into the form of a flask, in which the presence of small bubbles is very readily detected.

When a satisfactory "proof" has been obtained, the furnace is allowed to cool down somewhat in readiness for the next operation, that of stirring. We have already noted that it is this operation and its consequences which are the distinctive features of optical glass manufacture as at present practised—more or less in pursuance of the original invention of P.-L. Guinand. The stirring implement employed is a simple cylinder of fireclay, which for a pot of ordinary size would be some four to six inches in diameter and long enough to reach from the surface of the glass down to within about six inches of the bottom of the pot. The upper end of the cylinder is provided with a rim or

lip, while a square hole is formed in the centre, reaching some four or five inches from the top along the axis of the cylinder. This simple form of stirrer is made of the same fireclay as the pot, and is separately preheated or burnt. When the glass has cooled down to the proper temperature for stirring to commence, the fireclay cylinder is taken red hot from the kiln and is held in the pot over the glass for a short time in order to acquire the temperature of the glass. It is then carefully lowered down to the surface of the glass and slowly rolled over so as to become coated with glass, the inclusion of air-bells being avoided as far as possible. When it has thus been introduced into the glass, the stirrer is laid in such a position that it rests with its lip upon the edge of the neck-opening of the pot, the rest of the weight of the cylinder being easily borne by flotation in the glass. It then becomes necessary to close up the pot and

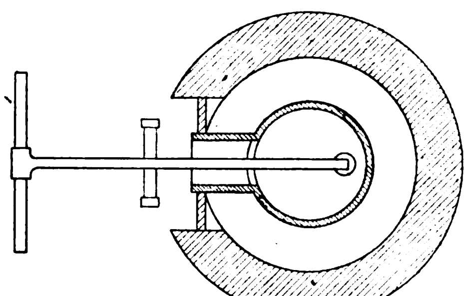

FIG. 5.
SKETCH PLAN OF STIRRING ARRANGEMENTS.

to raise the temperature in order to expel any air bubbles which, however carefully the operation may have been carried out, will yet have been caught between the glass and the clay cylinder. When time has been allowed for these to rise to the surface, the stirring operation itself may begin. For this purpose a long iron bar is used, one end of which is turned down into a short right-angled hook. The down-bent portion of this hook is pushed into the hole in the stirring cylinder, and consequently when the bar is held horizontally the cylinder is held in a vertical position in the glass, with its upper edge or lip an inch or so above the level of the surface. The relative position of stirrer, hooked bar, pot, and furnace at this stage has already been shown diagrammatically in Fig. 3. A plan view of the arrangement is shown in Fig. 5.

The stirring process consists in moving the fireclay cylinder round through the glass with a steady circular sweep, care being taken to keep the stirrer well away from the walls of the pot and also not to move it so rapidly as to throw up waves or splashes. Originally, this operation was entirely done by hand, and it was extremely laborious and trying on account of the heat and glare from the glass. Recently, however, it has been found possible to move the stirrer by mechanical means, and although it is said that the result is not as good as could be obtained by the best and most careful hand stirring, yet the mechanical method has the very great advantage of constancy and regularity and relative independence of individual skill.

The length of time during which stirring can be carried out continuously is limited by the fact that the glass cools down by loss of heat through the open mouth of the pot, and after several hours becomes too cold and stiff to be readily stirred. At that stage the stirring operation is suspended, the pot closed up and the glass reheated; then the stirring operation may be resumed. The total time of stirring required depends upon the nature of the glass: the denser flint glasses are known to need much more prolonged stirring than the lighter crown glasses, but this is a matter which can only be decided for each kind of glass by actual experience—and even then there is always a risk that in any given melting the stirring may have failed to produce the desired result, viz., the removal of striae. If the stirrer is allowed to come too near the wall of the pot and then drags with it some of the viscous glass rich in alumina which accumulates there, the further stirring operation may only serve to disseminate this viscous glass through the entire mass in the form of fine threads, which do not mix with the rest of the glass and leave it at the end full of striae and useless for optical purposes.

When the stirring has been carried on as long as is, in the judgment of the operator, necessary, the temperature is allowed to fall, and the stirring continued as the glass grows increasingly stiff, until finally the stirrer can only just be moved. At this stage the stirrer is brought round to the front and either left in the glass, with its lip resting on the edge of the pot, or it is sometimes slowly withdrawn, bringing a considerable quantity of glass with it. In either case, the individual stirring cylinder can never be used again.

The accelerated cooling which has been employed during the last stages of stirring is now permitted to continue a little longer, or—in the case of the modern gas-furnace—it is still

further accelerated by removing the pot entirely from the furnace. This operation is almost the exact reverse of that described in connection with the placing of the pot in the furnace at the beginning of the found, but with this difference that the pot is now full of glass and is consequently very heavy. Usually it is sufficient to place the pot on a fire-brick pedestal and to allow it to cool down naturally in the air until the surface of the glass is hard enough to ring when struck with an iron rod. In some glasses, however, there is a very strong tendency to crystallization, and this must be counteracted by more rapid cooling. In these cases a stream of water is sometimes directed upon the cooling pot. Even without this drastic measure, however, the cooling is generally so fast that the thick fireclay pot cracks in many places. Fortunately at this stage the glass is sufficiently thick or viscous not to escape through moderate cracks, and in order to prevent the formation of wider gaps the pot is wound with strong iron chains which hold it together in spite of cracking.

If the cooling of the glass were permitted to continue at the rapid rate just described, the contents of the pot would break into small splinters and become useless. As soon, therefore, as all chance of movement or crystallization in the glass has passed, the pot is placed in a kiln which has previously been heated to a dull red, and in this it is sealed up and allowed to cool slowly—the ordinary temperature being reached in three or four days. The kiln is then opened and the cracked pot with its contents withdrawn for examination. Sometimes the contents of the pot are found in the shape of one single block or lump of glass, but more frequently they consist of a considerable number of fragments of various sizes. These are freed from the pot, which is broken into fragments, and the glass is taken away for examining and sorting.

The first examination, which is made on the lumps as they come out of the pot, is necessarily somewhat rough, since the fractured surfaces of the glass do not allow of careful examination, and still less of testing by any of the means described in the first lecture. Coarse striae and defects such as bubbles, solid particles, etc., can be detected, and the piece of glass in which they occur is either rejected entirely or the defective parts are chipped off by the aid of a hammer. The selected blocks are then ready for the next operation, which consists in moulding the glass into some regular shape such as a block or plate.

The moulding process is a very simple one. The blocks of glass are slowly heated until they are soft enough to be plastic, and then by suitable means, such as moulds and presses, they are given the desired shape. Some skill is required in judging the necessary degree of softness for each kind of glass, and also in manipulating the glass with hand-tools before putting it into the press. This latter manipulation is necessary because the glass must not be allowed to fold or double over—no satisfactory joining-up would take place where two surfaces came together, and the "lap" would remain as a serious defect in the moulded block.

Moulding must necessarily be followed by "annealing," which in the case of glass consists simply and entirely of very slow cooling. If the glass is merely being moulded up into blocks for purposes of examination, and will have to be moulded into its final shape at a later stage, then ordinary slow cooling such as is obtained by sealing the glass up in a hot kiln and allowing it to cool down naturally, is quite sufficient. But if the glass has been moulded into its final shape, then very perfect annealing is essential. This is one of the most delicate and difficult of all the operations which optical glass must pass through.

It has already been indicated that extremely slow cooling is necessary for the "fine annealing" of optical glass. Fortunately, this slow cooling need not commence at any very high temperature; this depends, of course, upon the character of the glass, since the harder glasses will be stiff enough to set up strains at temperatures several hundred degrees higher than that at which the softer glasses will still be perfectly plastic. The actual range for "fine annealing" for the majority of glasses lies within the limits of 600° C. to 200° C., but even so, a cooling period of several hundred hours may be required, and very special appliances are needed in order to maintain such a slow rate in a perfectly steady manner.

For its final examination before sending it out for use, the moulded glass—now in the form of plates, prisms, blocks, discs, or even approximately moulded lenses — is roughly polished so as to make it possible to examine it carefully for striae, contamination, strain, etc. As the preliminary examination has necessarily been rough, a very considerable proportion of the glass is rejected at this stage, thus adding to the labour which has been lost in its preparation.

When the whole circumstances of the process

which has here been described in outline are considered, it will not be surprising to find that at the end, the yield of optical glass fit for use for the best purposes which can be sent out in the form of moulded plates or discs rarely exceeds 25 per cent. of the weight of the entire contents of the pot, while cases occur only too frequently where an entire melting is either lost during the found—as, for instance, by the cracking or perforation of a pot—or where it has to be entirely rejected owing to defects, such as striae or colour. Again, in other cases, the optical constants do not turn out exactly as desired, and the glass, which has been made to meet certain definite requirements, cannot be used for that purpose, and has to be put aside until an opportunity for disposing of it may arise. But there is probably no need to emphasise the difficulties of the process any further; it is not surprising to find that it is not regarded as a process of manufacture offering any great attraction from the commercial point of view—there is indeed room for surprise that such a process has been found capable of commercial application at all.

INDUSTRIES OF SPITZBERGEN, FRANZ JOSEF LAND, AND NOVA ZEMBLA.

SPITZBERGEN.

According to a report by the United States Commercial Attaché at Petrograd, plans have been under consideration for some months in that city for consolidating into one company under Russian organisation all the coal-mining claims and properties (including an important American property) in Spitzbergen, about 500 miles due north of Norway and nearly 80° north latitude. On this territory in the Arctic Ocean, which is about the last outpost toward the almost unknown region surrounding the North Pole, the coal-mining already carried on, chiefly by American capital, easily holds the "farthest north" record of organised industry, just as the penguin-oil industry of Macquarie Island in the Antarctic Ocean, belonging to Tasmania, has held the "farthest south" record.

Spitzbergen has a population of about 400 persons, mostly Norwegians, but including several Americans. Practically all the population is engaged in coal-mining, the most important operations being conducted at Advent Bay by an American company, which has been working its claims for ten years, and now takes out about 50,000 tons of coal per annum. All this coal, which is said to be of exceptionally high grade (soft coal, 15 per cent. superior to Newcastle coal), is shipped to Tromso in Northern Norway, and sold to the Norwegian Government for use on the State railways. There are also three Norwegian companies working claims in Spitzbergen, one at Advent Bay and two at Green Harbour.

To carry out the project of combining all the coal properties in operation at Spitzbergen under one company, there has been preliminary organisation of a syndicate of Russian capitalists in Petrograd, which, at a cost of over £4,000, bought options for the right to purchase before the beginning of the present year all the properties and claims in Spitzbergen, including those of the American company. A well-known mining expert was engaged by this syndicate to investigate the claims and properties in question, the intention being, in the event of the report proving favourable, to organise in Petrograd a company capitalised at over £800,000 to purchase and develop the mines and claims.

The conditions at Spitzbergen are unique, in that this is probably the only inhabited and promising part of the world that is under the sovereignty of no country, has no government of any kind, and no police force, courts, laws, or regulations. No person or company can expect to hold or own any property or claim in Spitzbergen unless it is actually worked or occupied. In case of any claim or property being usurped by newcomers, there could apparently be no redress or damages except by the use of force, or through negotiations between the Governments of which the two claimants might be subjects.

In June 1914, Norway, Sweden, Denmark, Russia, Netherlands, Germany, France, Great Britain, and the United States sent representatives to Christiania to organise some form of administration for the island, but adjourned on July 30th without completing their labours. The proposed resumption of their work in February 1915 was prevented by the war.

Communication with Spitzbergen is effected chiefly by means of a steamer belonging to an American coal company, which makes the distance of 400 miles between Tromso, Norway, and Advent Bay, Spitzbergen (one-third of the distance between Tromso and the North Pole), in about forty-eight hours. The passage between Spitzbergen and Norway is made only during June, July, August, and September, the ice around the island rendering it inaccessible during the rest of the year. The steamer mentioned can carry a load of 3,400 tons weight, and makes enough passages during the four months to take away from Spitzbergen the entire annual output of coal from the American mines, as well as to bring to Spitzbergen needed supplies and equipment.

While Spitzbergen is not mountainous, the surface is broken up by hills 400 ft. to 700 ft. high. All the coal is found above sea-level, mostly in two layers under the surface. It is mined with

comparative ease, conveniently near the coast-line, by driving lateral shafts through the hills. The ground is honeycombed with these shafts, until the surface above is supported only by a few columns. These are then taken away and the surface falls in, the mining then being easy, open work. As the coal is thus mined above sea-level and near the beach, its conveyance to the ship is simply arranged by letting it drop down through chutes.

As there is no timber in Spitzbergen, all that is used for dwellings or for mining purposes has to be brought from Norway. Most of the food also is imported, but there is a fairly plentiful supply of fish, seal, reindeer, and white bear. The climate of Spitzbergen, notwithstanding its extreme cold, is said to be remarkably healthful, and there is little or no sickness there. Moreover, the conditions of mining are exceptionally safe, owing to the fact that explosions of gas can never occur; the mines are free from water or dampness, and the formation of dangerous gases is impossible. The frozen condition of the ground and the location of the mines above sea-level account for the absence of moisture. Although Spitzbergen has never been carefully explored nor carefully studied except near the coast, surface indications point to the presence of many hundred million tons of coal in this remote northern part of the world.

Franz Josef Land.

About 200 miles east of Spitzbergen, and lying just above the eightieth degree of north latitude, is Franz Josef Land, which was discovered accidentally in 1873 by an Austro-Hungarian subject, and has been considered as belonging to Austria-Hungary. In August 1914, shortly after the European War broke out, an expedition from Russia, which had gone to Franz Josef Land primarily to rescue certain persons stranded there, planted the Russian flag and made formal claim to the land for the Russian Empire. There is a certain amount of sealing and fishing around the southern shores of Franz Josef Land, but it is not yet known whether this region, like Spitzbergen, contains resources of great economic value. The period during which ice conditions permit of visits to Franz Josef Land is much more limited than in the case of Spitzbergen.

Nova Zembla.

Nova Zembla, belonging to Russia, lying about 300 miles south of Franz Josef Land and separated by a narrow strait and by the Kara Sea from Western Siberia, is said to have resources in lead and copper, but the existence of such metals in paying quantities has never been carefully investigated. A small group of persons live at the southern end of Nova Zembla, chiefly those in charge of a wireless station for the Russian Government. The principal duty of the wireless station is to report ice conditions in the Kara Sea, so that navigators may be apprised concerning the feasibility of entering the waters north of Siberia, and also to report the presence of any persons shipwrecked, stranded, or caught in the ice. There is a fair amount of sealing and fishing around Nova Zembla, but no other industry at present.

OSAGE ORANGE EXTRACT FOR DYEING.

From a report recently published by the United States Department of Commerce, it appears that the production of osage orange extract on a commercial scale has been established in the United States, and this material is now available for the tanning, textile, paper, and other industries wherever a natural dye can be used. It is hoped that this will serve, not only to relieve the situation caused by a shortage of aniline colours in certain shades, but also in normal times to replace the use of foreign fustic by a wood indigenous to the country.

The study of osage orange as a dyewood was begun by the United States Forest Service about three and a half years ago, and was the result of an investigation of the utilisation of osage orange mill waste. As about 4,000 tons of fustic were imported annually for dyes, a series of competitive dyeing tests was made between the extract obtained from osage orange and that from fustic. This work was then extended by the co-operation of a number of textile schools. Later, the material was tried as a leather dye by Dr. L. E. Levi, of Milwaukee, and the entire subject was brought before the American Leather Chemists' Association last year at the Atlantic City meeting. A prominent firm became interested in the subject at this time, and is now producing the extract on a commercial scale.

The dye is the same as that present in fustic, but it is a pure compound, free from the varying admixture of a reddish colouring matter, which renders the use of tropical fustic somewhat uncertain. The orange-yellows, old gold, deep tan, olive, and chocolate shades obtained with chromium and iron mordants are equal to, if not better than, those obtained with the use of fustic.

The mill waste alone from the present manufacture of osage orange amounts to more than 25,000 tons annually, and if this waste could be set down at the mill for $10 to $12 (41*s.* to 50*s.*) per ton, it is believed that it could compete successfully with fustic in both cost of production and quantity of colour produced. The osage orange is found in large quantities in the Mississippi Valley, and is especially abundant in Oklahoma and Texas.

A NEW PHILIPPINE OIL NUT.

It appears, from an extract from the local press quoted by the United States "Commerce Reports," that a new oil nut has recently been discovered by accident in the Philippines. Some months ago, twenty-five bags of an oil-bearing nut were sent to Manila from Catanduanes as lumbang nuts. The recipient saw at a glance that they were not lumbang nuts, but did not know what nuts they actually were. He got in touch with the Bureau of Science, which was unable to identify the plant by the nut alone, but offered to extract the oil and investigate. This Bureau found that the nut produced 45 per cent. of a dark fatty, non-drying oil that made very good soap. Some time later leaves and wood were secured, and a botanist was able definitely to classify it as *Chisochiton cumingianus* (Harms) of the natural family Meliaceæ, the order to which santol belongs. He also stated that the field labels indicate it as "abundant," and that no information as to the presence of oil in the seed was on hand.

The recorded native names are: In Catanduanes and Camarines, balucanag; in Benguet and Union, batuakan; in Laguna, balucanag, kalimotain, salaguin; in Cagayan, marambolo, akalsa, macalsa; in Bataan, cato; in Albay, dudoa; in Bukidnon, valita; and in Negros, malacalad. The fruit grows to the size of a double fist in very large numbers on very large forest trees, each of the fruits having four seeds or "nuts" in them. A company in Manila has had two shipments of the nuts, one being of 288 piculs (39,600 lbs.). The oil is used for soap, and the company pronounces it satisfactory.

ARTS AND CRAFTS.

War Memorials at Conduit Street.—It is not unnatural that the question of war memorials and their design should be very much in the air just now. The times, the casualty lists, and our feelings all combine to bring the subject continually to our notice. It has been ventilated in the public press, lectures have been given upon it, and books brought out, and, what is perhaps still more important and significant, it is being very freely discussed by all sorts and conditions of people. Everyone seems determined that the memorials erected during and after this war shall be better than those from which we suffered after the campaign in South Africa. On the other hand, there seem to be very divergent views as to how a better state of affairs can be brought about. There are people who go so far as to say that memorials should always take the form of useful public works, and, short of this attitude, there are many who hold that memorial tablets and the like should be simple and comparatively inexpensive. There is, again, a growing desire that the most modest and private memorials should have some artistic value. All this is, undoubtedly, very much to the good, but the fact remains that the public as a whole is lamentably ignorant of how to set about finding more satisfactory memorials. It is difficult for them to know to whom to go for such work. The calling in of an artist is to many people rather a formidable undertaking, which is likely to involve them in expenditure on a scale beyond their means. Further, they do not know to whom they ought to apply. They are probably familiar with the names of a few painters, but of sculptors, carvers, stained-glass workers and other craftsmen they are quite ignorant, and, *faute de mieux*, they go to some shop or firm and take more or less reluctantly what is offered them. That may have satisfactory results (some firms take a pride in producing really good and artistic work), but very often it has not. The remedying of this state of affairs is one of the main objects of the Civic Arts Association, which held an exhibition of designs and models sent up in competition for prizes which they had offered, at the galleries of the Royal Institute of British Architects, last month. In assessing the success of such an undertaking at the present time we have to bear in mind the existing conditions. While it is true that many artists are badly in need of work, there is the other side of the picture. All the younger men who are physically fit are at the front or in training, and therefore this is not a time at which we are likely to discover a great amount of new talent. Competitors must be drawn from the men over military age, delicate men, and the women who are not engaged in war work. Some of the largest normal sources of supply are for the moment dried up. It would not be fair, therefore, to judge the recent exhibition by quite the ordinary standards. All things considered, it was in many respects a good deal better than could have been expected. The prize-winning designs in Class I.—the first by A. Richards and Henry Poole, the second by Eric Gill and Charles Holden—were both, in their very different ways, full of interest and of life, and there was other good work. The level in some of the classes, however, really hardly seemed above that of the student work sent up in the old local examinations of the Board of Education. There was one other rather serious defect in the working of the competitions. In some of the classes the work was estimated to be carried out for a specified sum, but it was not always apparent that either the competitors or the judges had paid much heed to the fact. As the association is prepared to put people who want memorials in touch with artists who will carry them out, this is rather a serious failure. Public confidence would have been more easily won had the fulfilment of the conditions laid down been insisted upon more rigidly. Again, the very charming design which took the prize in Class VII. was eminently unfit for a fountain on an open

site in a country town or village. It called aloud for a formal garden and a hedge planted at least fifty years ago—in short, for conditions sometimes to be found in private grounds, but difficult to contemplate in a normal town or village. Some of the simple memorials for the home were both suggestive and practical. Miss Ivan Kingsford's beautifully written and slightly illuminated little memorial parchment was altogether admirable, and would be fit for any surroundings, rich or poor. Mr. Arthur Stratton's rather classic medal stands, on which the decorations of the fallen could be hung, showed a happy inspiration satisfactorily carried out; and Mr. Rowley's box for mementoes was a good idea. If people can only be made to see that such simple objects are in many cases the most intimate and appropriate memorial, a great step in the right direction will have been taken.

The Decorative Art Group.—From the rather staid exhibition of the Civic Arts Association to the little show held at the Modern Gallery by the Decorative Art Group is a far cry. Despite the name of the exhibition, the works were mainly pictures with a certain decorative tendency. Mr. Carlo Norway's little "glinter glass" pots, the exhibits nearest to applied art, were neither very remarkable nor very beautiful, but some of his panels in which he has used all sorts of contrivances, such as combining different colours with, not stencilling, but a stencil plate, show the true decorator's joy in making the most of his material. Miss Nancy Smith's work too, especially the Robinson Crusoe panel with its beautifully curly waves, and the japanesque parrot, is executed with decorative intent and suggests great possibilities in the way of really artistic poster work. The exhibition was in some ways extravagant, but there was a note of sincerity about it, and some of the members of the group showed an unusual amount of feeling for and appreciation of decorative ideals and necessities.

NOTES ON BOOKS.

GIULIA HOFFMANN TEDESCO MICHELE TEDESCO L'OPERA. Prefazione di S. Di Giacomo. Milano: Alfieri & Lacroix.

The works of the two Italian artists Michele Tedesco and his wife are perhaps not very well known in this country, though two of Michele Tedesco's pictures are in public galleries in London; one at the Guildhall, "Sibariti," representing the invasion of a garden of the Pythagoreans by a party of Sybarites; and one in the Victoria and Albert Museum entitled "Gli Amici di Dante." It is, however, to be hoped that the publication of this work, consisting as it does of a large number of reproductions, both in monochrome and in colour, of the works of the two artists, may draw attention to their pictures.

Perhaps even in their own country their work, though well known, is less appreciated than it deserves to be; because it belongs to the older school of artists known as the Macchiaioli, such as Nino Costa and others, with whom the more modern schools have not much in common. Besides this, it has always been characteristic of the work of husband and wife that they were never much preoccupied by considerations as to the taste of their day, the criticism to which they were subjected, or the probability of selling their pictures. They have always conscientiously worked to give expression to their own ideals in their own way, and, as their admirers believe, were inspired by a culture and a sense of natural and spiritual beauty not common in much of modern production. Such independence of thought as their work exhibits naturally does not lead to great popularity, but its delicate beauty is admitted even by those who have little sympathy with its chief characteristics.

The book itself consists entirely of the pictures, which are left to speak for themselves, with the aid only of a very brief preface or introduction, which gives the very shortest account of the two artists, now both well advanced in years—for Michele Tedesco was born in 1834, and they have been married over forty years.

THE PRINCIPLES AND PRACTICE OF COMMERCE. By James Stephenson, M.A., M.Com., B.Sc. London: Sir Isaac Pitman & Sons, Ltd. 5s. net.

As a nation of shopkeepers, this country has perhaps been somewhat slow in turning its attention to the scientific study of commerce. Of late years, it is true, a good deal has been done to recognise the importance of the higher branches of the subject: many of our universities now give degrees in economics or commerce and in the London School of Economics we have a whole institution of university rank, admirably equipped and staffed and numerously attended, which devotes itself entirely to the more advanced aspects of the question. For students of this rank there is comparatively little difficulty in finding text-books and treatises dealing with the various branches of their curricula; but there is a much vaster army of less advanced pupils who have hitherto had difficulty in finding in one compendious volume a solid and reliable account of the elements of commerce.

Mr. Stephenson, the author of the book under review, has had experience which renders him singularly well fitted to write such a work as was required. As the head of the Higher Commercial Department of the Polytechnic, Regent Street, he knows precisely what is wanted by young students of commerce. The book, he says, has been specially written with

the object of meeting the needs of those preparing for the different stages of the examinations of the Royal Society of Arts and the Lancashire and Cheshire Union of Institutes. It is divided into nine sections: General Principles; Industry; Commerce; Trade; Exchange, Banking and Finance; Transport and Insurance; Warehousing; Monopoly; and the State in relation to Commerce. The author is a man of some academic distinction, and he treats his subject with a sound scientific thoroughness that ought to make it interesting and easily intelligible to his readers. A series of test papers enables the student to examine himself on the subject-matter of each chapter.

The great portion of the book strikes us as admirably clear and practical. We are not quite so certain of the value of one or two of the diagrams, notably those illustrating "Commerce in its relation to the Economic System," "Methods of eliminating Middlemen," and "Elimination in the Export Trade," for they seem to us only a complicated and laboured way of explaining the obvious. It is possible however, that for certain types of mind a diagrammatic representation is as comforting as the blessed word Mesopotamia is for others.

A TEXT-BOOK OF PAPER-MAKING. By C. F. Cross and E. J. Bevan. Fourth Edition. London: E. & F. N. Spon, Ltd. 15*s*. net.

The first edition of this well-known text-book appeared in 1888. Since then much care has been devoted to the scientific study of paper-making materials, and in preparing the fourth edition of their work the authors have taken pains to embody the results of their working experience of paper-making problems. Naturally also great advances have been made in connection with paper-mill machinery. This side of the work has been specially dealt with by Mr. J. F. Briggs, who writes with a very wide practical experience of the subject.

A valuable feature of the book is its sixteen plates and ninety-nine illustrations, particularly the admirable photo-micrographs prepared by Mr. John Christie, who also supplies some of the matter in the very interesting chapter on statistics of the paper trade.

The volume forms a thoroughly practical and up-to-date text-book for all interested in the manufacture of paper, while those who wish to study any branches of the subject in greater detail will find a useful guide in the bibliography.

GENERAL NOTES.

POTASH IN LAKE MUDS IN UTAH.—Potash in large proportions is present in the brines and muds of the Salduro Marsh, a sink in the Salt Lake Desert, about 60 miles west of the south-west edge of Great Salt Lake. From the clays underlying the salt body which covers the marsh, the United States Geological Survey collected samples at depths of 8 to 12 ft., in which the dissolved salts were found to contain from 2 to about 3¼ per cent. of potash, and 2½ per cent. was found in the soluble salts at a depth of about 4 ft. According to analyses made by the Survey, the brines and muds from the Salduro Marsh contain considerable magnesium chloride as well as chlorides of potassium and sodium, and so are somewhat similar in composition to the deposits from which potash is manufactured in Germany.

RATTAN-FURNITURE INDUSTRY AT HONG-KONG.—The raw material for the Hong-Kong furniture industry comes from a variety of sources. The best price, according to a United States Consular report, is paid for that from Sarawak and British North Borneo, but supplies from the Dutch East Indies, French Indo-China, and the eastern and northern parts of the Malay Peninsula are also handled. Practically all of it comes to Hong-Kong direct from Singapore, being shipped to the agents of dealers of the latter place. When shipments arrive at Hong-Kong the agents distribute samples to the trade, and the supply is auctioned off. Several species of rattan grow in Southern China, but not in sufficient abundance to be exploited commercially. Very little of the Philippine product reaches the Hong-Kong market. Since the outbreak of the war the prices of both raw and prepared rattan in Hong-Kong have increased 50 to 75 per cent., mainly as the result of inadequate shipping facilities. The best grade of cane is now claimed to bring as high as $400 per long ton.

ADHESION TESTS FOR FABRICS IN RUBBER INDUSTRY.—The United States Bureau of Standards has installed in its rubber-testing laboratory a newly-designed autographic machine for testing the "friction" or adhesion between the different plies of canvas used in rubber hose, rubber belting, automobile tyres, etc. This machine, by means of a diagram that is made automatically during the test, shows the exact value of the adhesion between adjacent layers of fabric at all points. The machine was designed and built at the Bureau of Standards. The bureau is experimenting with several rubber compounds that have been made into eyeshades for use in connection with the range-finders on battleships. Some of these shades have been moulded in the bureau's experimental laboratory, and will be tested in service to ascertain the compound best suited for such use. An important recent test was in connection with fire hose purchased for use in the district of Columbia. Samples representing 28,000 ft. of fire hose were tested both physically and chemically to determine if the specifications had been complied with.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

OPTICAL GLASS.

By Walter Rosenhain, D.Sc., F.R.S.,
Superintendent, Metallurgy Department,
National Physical Laboratory.

Lecture III.—Delivered December 13th, 1915.

In the previous lecture I have discussed in some detail the present process of optical glass manufacture and have dwelt upon some of its difficulties. Some of these are more or less peculiar to English circumstances, but the majority of them are inherent in the process as it is at present practised. It is only fair to point out that these difficulties are largely responsible for the fact that a vigorous and prosperous optical glass industry was not developed in this country in the first decade of this century. It is, perhaps, not too much to say that the manufacture of optical glass is even at the present moment not really a commercial process, and it is doubtful if it has been carried on in recent years as an independent profitable industry. In Jena there is little doubt that financial success has been achieved by the close inter-relationship of the firm of Schott with the immensely successful enterprise of Zeiss. In addition to this profitable co-operation between the glass-maker and the optical instrument maker, the Jena firm has undertaken glass manufacture on other lines besides those of optical glass—such as chemical laboratory ware, and more especially lamp-chimneys for gas-burners. These activities, taken up by a firm originally intended to deal only with the production of optical glass, serve as a good indication of the business aspect of the manufactures in question. We may, then, well inquire as to the future prospects of optical glass manufacture in this country, and I think there are only three courses open to us. The first is that of *laissez-faire*, as a result of which optical glass production would be left more or less in the old groove or to the efforts of those who regard the matter from the purely business point of view. The probable results of that course may be gauged from what was achieved between the years 1905 and 1914 by effort on the same basis. The second possibility is to aid the industry by some form of subvention or fiscal protection. Such protection may, perhaps, be justly claimed by firms or individuals who have put money and energy into an effort to meet the emergency demands for optical glass at the present time of crisis. But there are obvious disadvantages in such a course—leading to questions which I cannot discuss here. This much, however, is obvious: that if our industry needs State aid or protection we have yet fallen short of what should be our real object—viz., that of being able to meet the competition of Germany on an equal footing in the open markets of the world. The third course is by far the most difficult, but it is the only one which can lead to real success in this as in any other branch of technical industry; this course is the vigorous pursuit of a policy of progress—of setting about discovering the best way to deal with this problem of producing optical glass—by means of laboratory researches and works experiments—by scientific activity and industrial enterprise to put this industry on a better and more rational foundation, so that we may learn how to make better optical glass and to make it more cheaply than has yet been done elsewhere. If we do this we shall gain a real leadership, and with it the proper fruits of such a victory. But such victory requires to be organised, even as military victory does, and it cannot be gained if we are afraid to incur the requisite expense. Happily there is evidence that this strong course is to be pursued, and, in fact, vigorous research work is already well in progress.

While the results of any campaign cannot be predicted, it is of considerable interest even at this stage to survey the ground to be covered, and to consider the lines upon which the problem

must be attacked. It is the survey from this point of view which I propose to undertake in the present lecture.

If we consider the present process of optical glass manufacture carefully, we see at once that its disabilities as a commercial process arise from the fact that it is long and laborious and only produces a relatively low yield of saleable product. For the production of something between 250 and 350 lb. of good optical glass we have a series of operations occupying at least a week—not counting the time of producing the pot—and involving much manual labour and skilled supervision and a large quantity of relatively costly raw materials. Even then, there are risks of total loss to be reckoned with each time. It therefore becomes interesting to inquire why the process is so lengthy and laborious.

The long duration of a "melting" arises principally from two factors. In the first place the temperature employed must be carefully regulated, and cannot be indefinitely increased in order to secure really rapid and efficient melting. There are two special reasons for controlling temperature in this way. In the first place, the chemical action of the molten glass upon the wall of the pot exposed to contact with it increases rapidly with rising temperature. With the more active kinds of glass, unduly high temperature at once results in the destruction of the pot by "drilling"—the glass simply eats its way through the pot in a few isolated spots. But even apart from this, the pot itself cannot stand an excessively high temperature—the fireclay of which pots are usually made becomes soft at a bright white heat, and the weight of the molten glass would bulge the pot and lead to its destruction if temperatures like 1800° C. were used. On the other hand, the use of very high temperatures is essential if the rate of melting is to be materially accelerated. Here, of course, the heat-resisting power of the furnace itself would also be involved, but this is essentially the same problem as that of the pot—since both furnace and pot are usually made of the same type of refractory material.

But even without employing furnace-temperatures higher than those at present in use, it would be possible to accelerate the melting of the glass very much if it were possible to use a simple open pot or crucible instead of the domed covered pot—somewhat like a flat-bottomed retort—which is at present employed. With the open pot, the heat of the furnace has direct access to the glass or the glass-making materials, but in the covered pot the heat has to pass through the walls of the pot and of the dome—with the result that the rate of melting is materially diminished for a given type of glass and a given furnace temperature. We therefore inquire what are the reasons for using the covered pot in the melting of optical glass?

The answer is that the use of the covered pot is simply the result of adopting the ordinary process of flint-glass making. Flint glass, which is, of course, lead glass, is always made, in this country at all events, in covered pots very similar in shape to those used for optical purposes. Now, in the early days of optical glass manufacture, the real problem was to produce optical *flint* glasses, and the obvious step was to adopt the process of the habitual maker of flint glass. This adaptation was perfectly rational, because in the making of lead glass it is necessary to protect the molten "metal" from contact with reducing gases such as those which exist in the furnace—and more particularly in the old coal-fired furnaces. Protection is also needed from contamination by flying ashes and dust, and even by "droppers" from the crown of the furnace, and this necessity applies with equal force to the production of optical flint glasses, so long as the same type of furnace is used. Recently, by the rational use of the regenerative gas-furnace, some French works have succeeded in producing excellent flint (lead) glass in simple open pots, and for optical purposes some types of "crown" glass have also been made in open pots. It must be admitted, however, that for a large number of optical glasses such a proceeding is out of the question; in fact, the degree of protection from furnace gases which is secured by the use even of the covered pot is not really adequate—the hot fireclay is sufficiently porous to admit of a certain amount of diffusion of the furnace-gases into the interior of the pot. The rational solution of such a difficulty would therefore seem to be—if we cannot exclude them satisfactorily and have to use an inefficient and clumsy covered pot on their account—to eliminate the ordinary furnace gases entirely. The means for doing this would appear to lie at hand in the modern development of the electric furnace, and it seems at all events possible that in this direction may lie one of the lines of future progress in the production of optical glass.

With this possibility in view it may be worth while to glance very briefly at the various existing types of electric furnace and to consider their possibilities from the present point of view.

Essentially there are only three types of electric furnace in existence, together with types which are combinations of two of the fundamental forms. These three types are the "resistance," the "arc," and the "induction."

The "resistance" type of furnace is by far the simplest in every way. In its most elementary form it consists of an electric conductor, which is heated by the passage of a suitably large electric current. Usually this conductor is so arranged as to surround—more or less completely—the furnace-space proper where the objects to be heated are placed. The ordinary electric tube furnace, in which a metallic wire or tape serves as resistance, is limited in regard to temperature by the properties of the metal employed. Even platinum, which is prohibitively expensive for any but laboratory purposes, cannot resist a temperature exceeding 1400° C. for more than a very short time; the recently-introduced refractory alloys containing large proportions of nickel and chromium (known as "nichrome") cannot be continuously used for temperatures exceeding 1200° C. For glass-melting purposes, where any but the most fusible glasses are concerned, these temperatures are insufficient. But the resistance type of electric furnaces is not confined to those using metallic resistances. Carbon resistance furnaces have been made and worked on the large scale, both in the form of tubes or rods of carbon serving as heaters and also by the employment of resistances formed of granulated carbon contained between walls of suitable refractory material. But in these types there is much room for development, since none of the existing forms are readily applicable to glass-melting. In these, as also in the "arc" and the "arc resistance" type, if the carbon is not to be rapidly consumed, a strongly reducing atmosphere must be maintained, at all events in the spaces immediately surrounding the carbon. In the glass-melting chamber of a furnace, however, if open pots are to be used, an oxidising atmosphere is essential, and thus one of the special problems to be faced in applying electric furnaces working with carbon to glass-melting purposes consists in finding satisfactory means whereby the reducing atmosphere surrounding the carbon can be effectively separated from the oxidising atmosphere required in contact with the glass.

The induction furnace, the best-known types of which are those of Kjellin and of Roechling-Rodenhauser, depends upon the generation of extremely powerful alternating electric currents in the material to be heated, by the process of induction. For this purpose the electric power is applied as an alternating current passing through a set of windings placed on a large magnetic "core." This "core" passes through the centre of the furnace, the crucible or melting-chamber being arranged as a ring or annulus around this core in such a way that the contents of the crucible form a "winding" of one single turn about the core. The whole arrangement acts as a transformer, and when an alternating current is passed into the external coil currents of lower voltage but correspondingly higher current density are generated in the contents of the crucible. The working of this type of furnace, however, requires in the first place that when the electric current is first turned on, the contents of the annular crucible shall constitute a good conductor of electricity. Now glass only becomes a conductor at a fairly high temperature, so that a furnace of this type could not be started from the cold state. Even if this difficulty could be overcome by means of auxiliary heating appliances or by other means, the difficulty still remains that the crucible must be of the ring form. This form would be so disadvantageous from the point of view of the area of glass in contact with the refractory containing vessel as to put this type of furnace, in my opinion, entirely out of court for the present purpose.

Of an entirely different type and offering totally different conditions are the "arc" furnaces. In these, the heat is generated by one or more electric arcs, playing between carbon electrodes in the upper part of the furnace chamber, leaving the heat to be conveyed downwards to the contents of the furnace by radiation and conduction. Where extremely high temperatures are to be employed and only small quantities of material are to be treated, the arc can be used to play directly upon the object to be heated. In the furnaces of the "Stassano" type, on the other hand, the intense local heating effect of the arc is not desired, and here a number of arcs play in the upper part of a furnace chamber, the heat being moderated and equalised by keeping the arcs at a little height above the contents of the hearth or "crucible." At first sight it would seem that this mode of electric heating was directly applicable to glass-melting, but two serious difficulties arise. The first of these is again the question of the reducing atmosphere generated by and to some extent necessary to the arcs themselves, while the second arises from the fact that the carbons used for carrying the arcs are gradually consumed and that the ash which is left by their

combustion, as well as fragments of the carbons themselves, would fall down into the glass below. If an intervening dome or roof must be employed, then the disadvantages of the ordinary gas-fired furnace are again admitted. The use of the arc-furnace pure and simple would thus seem to be somewhat difficult, but it is quite possible that a modification of this type of furnace could be devised which would render it directly applicable.

The "arc-resistance" type of electric furnace, however, which is so largely used in steel metallurgy at the present time, would appear to offer rather more interest from the glass-melting point of view. As an example of this type of furnace, we may take that variety in which two carbon electrodes are used, hanging down from above with their lower ends close to the surface of the molten material in the hearth of the furnace. Between each of the carbons and the molten material an arc is formed, the current passing from one arc to the other through the molten layer. In steel metallurgy, of course, this layer is the slag with which the surface of the steel is covered. Theoretically, the molten glass itself, or even the raw materials in incipient fusion, might serve to carry the current, but if this were done the difficulties just described in regard to the simple arc furnace would still apply. But in order to suggest the directions which adaptation to the needs of glass-making might take, it may be mentioned that most of these difficulties would be avoided if the molten or melting glass could be covered with a layer of molten material of a different kind, much as the steel is covered by the slag. For instance, fused sulphate of soda floats upon the surface of molten glass without mixing with it to any considerable extent, and no doubt other fused salts or mixtures of salts could be found to answer such a purpose.

Another possibility consists in using such an arc-resistance furnace, or any other type of electric furnace, to heat a bath of neutral slag, or even of metal, and to immerse the crucible in which glass is to be melted in this bath. This arrangement, again, would overcome most of the difficulties of the arc furnace, but other difficulties would arise, such as that of keeping the current-density on the two sides of the crucible equal so as to avoid local over-heating. The necessity of avoiding the "pinch" effect, which tends to constrict and finally to disrupt a liquid conductor when too great a current-density is applied to it, would also have to be borne in mind. I do not suppose, therefore, that either of the proposals here indicated is likely to offer the final solution of this problem; they serve, however, to suggest that adaptation and modification are both necessary and possible if the problem before us—of adapting the electric furnace on the large scale to the production of optical glass—is to be solved. We have here one of the problems upon which research in this subject should be directed.

Apart from all questions connected with the furnace, the main difficulties which we have discussed in our brief account of the process of optical glass manufacture have been related to the crucible or pot in which the glass is contained during the whole operation. The mere production of the pot and the process of getting it ready for the melting operation is very long and laborious and full of risks of failure and loss. The operation of building the pot up out of the previously prepared fireclay is a matter occupying a period extending over four months, and at least four further months are needed before the pot is sufficiently dry. Most glass-makers prefer to dry their pots for at least six months before taking them into use. And during the entire period, careful supervision is needed, since any considerable oscillation of temperature in the pot-rooms is apt to cause cracks.

When the pot is safely "air dry" it has to be taken out of the drying-rooms and transferred to the pot-arch, where it is to undergo its preliminary burning. If it escapes injury during transit, it may yet be ruined—as we have seen in the previous lecture—by a single "flash" of premature flame licking over it. Thus the pot, when "set" in the furnace, safe and sound, and ready for filling, represents a decidedly costly product. The circumstance that for each melting one such pot must be sacrificed therefore represents one of the most serious drawbacks to the whole process from the commercial point of view. For the sake of economy in production, therefore, it becomes a matter of first-rate importance to devise means whereby the same pot might be used for a whole series of successive meltings. If this could be done, it would easily counterbalance any increased cost of the pot itself, such as might arise from the use of raw materials for pot-making rather more costly than the present fire-clays.

The troubles for which the pot is responsible do not end, however, with the destruction of the pot itself at the close of a successful melting. Actually, the low yield of useable glass (20 to 30 per cent. of the total glass melted) and the occasional failure of entire meltings, are largely traceable to the nature and properties of the pot. Fire-clay is an impure silicate of alumina,

generally containing more or less free silica mixed with it, and also contaminated with iron in various forms of combination. Now all these materials can be, and are, used as actual constituents of various kinds of glass, and all of them are to a greater or less extent soluble in glass—much as sugar is soluble in water. When, therefore, glass is heated for a long period in contact with a vessel made of these materials, a certain amount of attack occurs and the glass gradually dissolves the constituents of the clay. This process only occurs slowly and to a small extent with most ordinary varieties of glass, such as ordinary sheet or flint glass, so that the pots withstand many meltings of these types of glass before they are so far dissolved away as to fail. But in the case of certain kinds of optical glass the rate of solution is very rapid. The rate of attack attained by a dense barium glass, when the temperature is kept fairly high, is indicated in Fig. 6, which is a photograph slightly magnified (10 diameters) of a cross-section of the wall of a pot which has been exposed to the attack of such glass for three hours. The original thickness of the wall is indicated by the dotted line. Here the attack has been fairly uniform over the entire surface of contact of glass and pot; in other cases, such as that illustrated by the section photographed in Fig. 7, the glass appears to find a few weak spots in the clay and the pot is then "drilled" with astonishing rapidity. A pot 3 in. thick

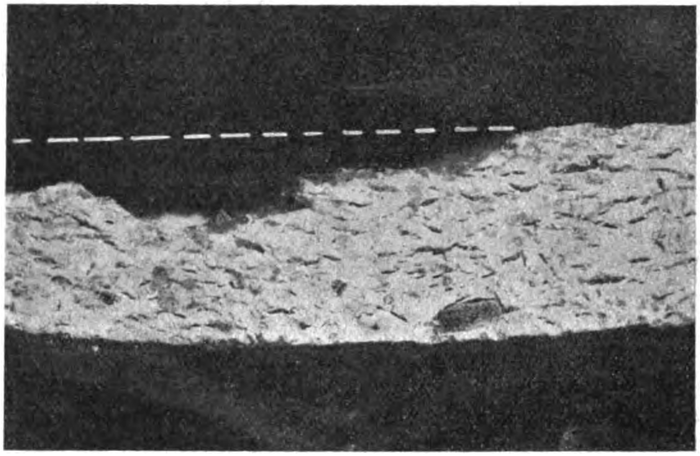

Fig. 6.

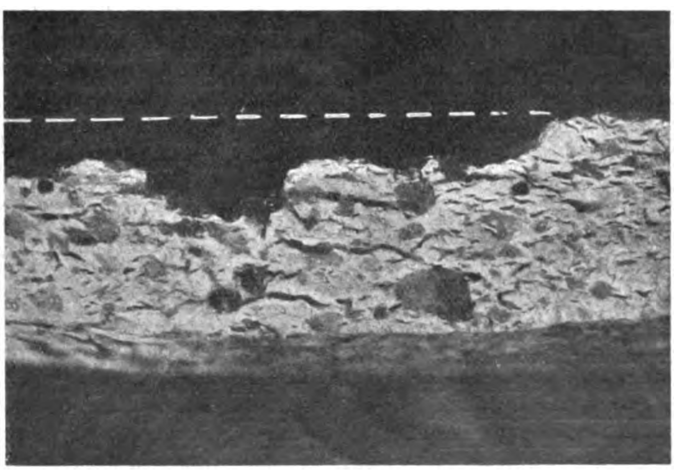

Fig. 7.

may be pierced in this way in two or three hours.

The worst evil which arises from this action of the glass upon fireclay, is not the mere mechanical destruction of the pot itself, but the resulting contamination of the glass. Where the fireclay contains a notable amount of iron, this is rapidly "washed" out by the glass, which—if it is sensitive to colouring oxides—rapidly assumes a greenish tint. The presence of notable proportions of iron can be largely avoided by the choice of particularly pure clays, but the glass also dissolves silica and alumina, and these are essential constituents of the clay. It is true that silica and alumina do not produce colouration of the glass, but they contaminate it none the less by producing close to the walls of the pot a layer of glass rich in alumina. This glass is extremely viscous and will not readily mix with the rest of the contents of the pot, while it is also distinguished by a markedly different index of refraction. During the stirring process, care must be taken to avoid dragging this thick viscous glass away from the sides of the pot, and the stirring cylinder is therefore made to give the walls of the pot a wide berth. This, however, results in two difficulties. In the first place, it limits the vigour of the stirring operation, and the risk is run of not stirring the glass enough to render the body of it homogeneous, for fear of spoiling the whole by dragging cords or veins of the aluminiferous glass from the pot-walls into the body of the glass. Further, even if the stirring operation is successfully concluded and the glass in the centre of the pot is free from striae, the glass must be allowed to "set" as rapidly and with as little disturbance as possible lest the stringy glass around the sides should be permitted to mix with the good glass in the centre. This is why it is essential to allow the glass to cool in the pot in which it was melted —thus necessitating the destruction of the pot at the end of the melting, instead of removing it by ladling, pouring or gathering and thus leaving the pot available for further use.

It would thus appear that the solubility of the material of the pot in molten glass is one of the worst features of the present process of optical glass making, since it gives rise to all the most seriously disadvantageous features of the whole process.

The first aim of research intended to bring about the improvement of optical glass making must therefore be the improvement of the pot with a view to rendering it, if possible, completely inert and insoluble in the molten glass to which it is to be exposed. If the solubility of the material of the pot in the molten glass were eliminated, most of the difficulties of optical glass making would vanish. The removal of striae could be completely effected by vigorous mechanical stirring which need take no heed of leaving the outer layers of glass undisturbed, while the glass, when finally stirred to complete homogeneity, could be rapidly removed from the pot, and the pot could be used again and again. Even if this complete solution of the problem is not attained, any notable progress in that direction would be of considerable value, as it would tend towards a greater yield from each individual melting and to the reduction of the number of entirely useless meltings.

The material of which glass-melting pots are universally made is the substance known as "fireclay." The constitution and properties of fireclays have of late years formed the subject of much detailed study and investigation, principally in Germany and America. Chemical purity, combined with certain well-defined physical properties, has been recognised as the primary necessity for good fireclay. As in the case of sands, so also in regard to fireclays Germany is fortunate in possessing specially good natural resources, and these have been thoroughly studied and exploited on a sound scientific basis. As a contrast to this we may take the attitude of certain British clay-workers: one of the firms concerned, in answer to a request that they should supply a sample of their best pot-clay for purposes of experiments intended to improve pots for optical glass making, wrote to the effect that their pot-clay was already so good that they did not see that any experiments could possibly improve it. Fortunately, this is an illustration of an extreme attitude not adopted by many of those concerned, but the fact remains that such fireclay resources as we possess in this country are not as fully studied and utilised as they should be. Quite recently great progress has been made in regard to certain types of refractory goods, such as gas retorts, but in regard to glass pots the best available British material is still far below the standard attained in Germany. A first step towards the elimination of what we may term "pot troubles" in regard to optical glass is, therefore, the systematic study of fireclays and the production of better clay pots. And our survey for this purpose should extend throughout the Empire, in order to supplement the resources of this country with those of the wider lands beyond the seas.

While thus strongly urging the necessity for improvement in regard to our fireclay pots, I think that it would be too much to expect that any fireclay would suffice to solve the problem with which we are here faced—viz., that of providing an entirely inert melting vessel for optical glass. In order to effect further improvement we must either abandon clay entirely and turn to totally different refractory materials, or we must in some manner protect the clay from direct contact with the molten glass. One of the most obvious ways of doing this would seem to be by coating the fireclay with a refractory and inert glaze such as the glaze that is used on porcelain or earthenware intended for containing acids, etc. The problem, however, is much more difficult, because while the ordinary porcelain glaze has only to resist the acid at temperatures far below a red heat, the glaze on a glass-melting pot would require to resist the action of molten glass at a very high temperature—a red or even a white heat. It would thus seem necessary to employ a glaze whose melting-point is much higher than that of the glass to be melted in the pot. Such "glazes" could, no doubt, be prepared, but the difficulty of applying them would be extreme, as a moment's consideration of the case will show. A "glaze" can only be applied to the surface of a pot by melting it on. In ordinary pottery the material of the glaze is applied to the surface of the "biscuit" pottery in the form of finely-divided powder; the whole is then heated until the materials of the glaze melt and form a continuous coating over the surface. An essential condition for this operation is that the material of the pot should be much less fusible than that of the glaze, since otherwise the pot itself would soften and melt while the glaze was being melted on. In the case of the glass-melting pot, however, it would be difficult, if not impossible, to fulfil this condition, since the temperature required to melt the glass itself is generally quite as much as the pot can stand; "melting on" a still more refractory glaze would therefore be impossible —unless, indeed, one had at one's disposal a "fireclay" whose softening temperature lay many hundreds of degrees above the temperature required for "fining" the glass. Even the best of known fireclays do not approach this degree of refractoriness. In practice, up to the present time, the application of "glazes" is confined to two operations. The first of these has already been described; it consists in "glazing" the inside of the pot with molten glass of the same kind as that which is to be melted in the pot; this procedure, however, merely serves to protect the pot from the violent action of the raw materials, and in no sense can it protect the pot from the action of the glass itself. The second operation consists in glazing the outside of the covered pots with some refractory glaze, applied in strictly limited quantities, for the purpose of closing the pores of the pot and preventing or retarding the entry of furnace gases into the pot. Since the pot is very porous and tends rapidly to absorb any liquid spread over its surface, this process is of doubtful value; either the glaze is absorbed by the pot without filling its pores or, if enough is used to stop the pores effectively, it acts as a flux and brings about the fusion and destruction of the whole pot.

It would thus appear that if fireclay pots are to be protected from the attack of molten glass this will have to be done by means of a refractory lining—*i.e.*, of a lining which is not melted during any of the operations. Such linings are well known in metallurgy, and it does not seem unlikely that they can be employed for the present purpose. There are, however, serious difficulties to be overcome. The first and most fundamental of these is that of finding a lining material which is really indifferent or inert to the action of molten glass. Fortunately, there is some hope that such materials may be found. Beyond this, comes the difficulty of forming such materials, which will probably not possess the remarkable plastic properties of clay, into linings and of making these linings adhere to the fireclay walls of the pot. Finally, the shrinkage of the clay during burning, and the difference in shrinkage and in thermal expansion and contraction between the walls of the pot and the lining, all tend to disintegrate the latter. The difficulties of this type, however, have been successfully overcome in the case of ordinary pottery work. If an unsuitable glaze is applied to a given piece of ware, on cooling after firing the glaze is found to be cracked—or "crazed" —in all directions; in extreme cases the glaze may even chip off entirely. When this occurs it is due to a difference in the contraction of the body and the glaze, and it can be corrected, in most cases, by varying the chemical composition of the glaze in such a way as to adapt its physical constants to those of the body. If this is not entirely possible, a "modus vivendi" may sometimes be found by interposing an accommodating layer having intermediate properties, so as to soften the contrast between the two materials. It seems probable that similar

devices could be employed in the case of refractory linings in fireclay pots. A further difficulty arises from the very refractory nature of the lining material. The latter, in order to be converted into a reasonably coherent mass, must be raised to a temperature where its most fusible portions are approaching fusion; when thus heated, the material becomes "fritted" and attains the requisite degree of strength. But in the case of certain extremely refractory materials, the temperature required for this purpose is so high that the fireclay itself could not resist it. Here again it will be necessary to adopt devices which will surmount this difficulty; but the use of the most refractory fireclay will in itself serve to diminish it.

Finally, if the difficulties just indicated cannot be overcome by any reasonable method, it may become necessary to depart from fireclay entirely, and to adopt some different refractory material for our pots. The very great possibilities which exist in the way of "new" refractory materials are indicated by a number of new products which have been developed in America, where this branch of the subject has received very great attention. There the view has rightly been taken that the advance of metallurgy and of furnace practice generally is dependent upon better refractories, and as a result we have such valuable materials as alundum, carborundum, siloxycon, etc., and the possibilities are doubtless still far from being exhausted. Here again the electric furnace offers the means for exploring new fields, since the properties of many substances are materially altered by preliminary heating or even melting in the electric furnace at extremely high temperatures. The electric furnace may thus become of primary importance to optical glass manufacture as a means of preparing the necessary refractories.

The whole question in regard to the problem of the melting pot for optical glass thus becomes one of finding the suitable material and means for utilising it on the large scale. Just as the work of Schott and Abbe was epoch-making, because they introduced new materials into optical glass itself, so the next great forward step in this industry will be made by the introduction of a new material for the pot in which the glass is to be melted.

The difficulties which beset the production of optical glass, in so far as we have yet considered them, arise to a considerable extent in the production of all types of optical glass. There are, however, other troubles which are peculiar to certain types of glass. Thus, in the case of flint glasses, which contain large proportions of lead oxide, there is the well-known effect of reducing gases, which blacken the glass by the reduction of metallic lead. For this reason the use of the covered pot is regarded as essential by all makers of flint-glass in England. In certain works in France it has been found possible to make flint glass in open pots by the use of a special type of gas-furnace in which the flame itself is kept away from the pots and an oxidising atmosphere is maintained around the pots.

These flint glasses also exhibit an exceptionally great tendency to develop striae, and to exhibit small but noticeable variations of their optical constants in different levels of the pot. This arises from the difficulty of stirring these glasses as vigorously and thoroughly as would otherwise be desirable, although slight losses by volatilization from the surface of the glass may also play a part in the matter.

Still more serious difficulties of a special nature arise in the case of the very dense glasses of the "Barium Crown" type, which are of such great importance for optical uses. These glasses combine a relatively high refractive index (ranging up to and above 1·61) with a low dispersion (ν values up to 60). In order to attain these optical constants, such glasses are made with a barium-content of from 40 to 50 per cent., combined with 10 to 15 per cent. of boric acid and very little silica. These glasses, therefore, constitute extremely basic fluxes. This can be best realised by expressing their composition in terms of chemical symbols, so as to obtain an idea of the relative proportions of basic and acid molecules as compared with the same ratio in the case of a standard glass of the "hard crown" type. The two formulae read—

Very dense Barium Crown $Na_2O, 4BaO, 2B_2O_3, 2SiO_2, Al_2O_3$.

Typical Hard Crown . . . $Na_2O, CaO, 6SiO_2$.

The consequence of this extremely basic composition is, in the first place, very violent action upon fireclay; one of these glasses if strongly heated will drill holes through a thick fireclay pot in a few hours. A further difficulty with these glasses is their extreme sensitiveness to colouring materials. Melted without very special precautions, they assume a deep green tint. To some extent this colour arises from minute impurities in the raw materials, but beyond this there is some definite colouring action which occurs in the furnace; the iron contained in the material of the pot itself plays a part in

this action, but so do the furnace gases, since the same mixture and pot, employed in an electric furnace free from all carbon and sulphur gases, yield a colourless glass, while a deep green colour is produced in the ordinary gas furnace. It appears probable that the presence of sulphur and the resulting formation of a barium-aluminium-sulphur compound, somewhat of the type of "ultramarine," may come into play.

The extreme glasses of this type are subject to a further series of difficulties. One is that of freeing them entirely from small gas-bubbles. Interaction between glass and pot, and possibly between glass and furnace gases, appears to generate fresh bubbles as the melting proceeds, with the result that the glass is never entirely free from them. Their relatively harmless nature has already been discussed. More serious is what we may term the chemical instability of these glasses. This manifests itself in the finished glasses by liability to tarnishing and dimming of the surface owing to the action of the moisture and carbonic acid of the atmosphere. Sensitiveness in this respect is due to the fact that the barium silicates and borates present in the glass—which are themselves fairly stable bodies—are heavily laden with excess of free or very loosely combined barium oxide, which is left free to react with moisture and carbon dioxide.

During the cooling of these glasses from fusion, the fact that we are dealing with heavily-laden solutions makes itself evident in a strong tendency for the cooling solution to deposit its heavy burden in the shape of crystals which are formed during cooling. This tendency to crystallize during cooling may be counteracted to a certain extent by accelerating the cooling of the molten glass; the pot may be drawn out of the furnace and cooled in the air, and it may even be cooled still more vigorously by the aid of a jet of cold water. But even the most drastic methods cannot accelerate the cooling of a large mass of glass beyond a certain point. That this is so can be clearly seen if a large mass of molten glass is poured into water; the interior of such a mass remains visibly red hot for a long time in spite of the rapid cooling of the outer layers. It follows that in the case of a pot of glass intended for optical purposes a limiting composition will be reached when the glass still undergoes crystallization in spite of the most rapid cooling which can be applied to it. This circumstance supplies one very definite limit to the range of optical glasses which are attainable, in one direction at all events.

An interesting side-issue arises in regard to the determination of the temperature from which chilling must begin in the case of glasses which undergo "devitrification" or crystallization during normal cooling. It is obviously important to know the exact range of temperature through which rapid cooling is essential, in order to avoid on the one hand unnecessary risk involved from chilling the glass at an unduly high temperature, and on the other the risk of allowing the mass of glass to break up into useless fragments by carrying the chilling process down to too low a temperature. The necessary knowledge can be obtained by the application of a method with which metallurgists are familiar—viz., the taking of a "heating curve." For this purpose a small piece of the glass in question, which has been allowed to devitrify or crystallize as completely as possible, is slowly heated up in a suitable furnace and its temperature is observed, by means of a thermo-couple, at regular short intervals. When the temperature is reached at which the crystals present in the devitrified mass begin to melt, a retardation in the rise of temperature of the glass will make itself felt, and this will continue throughout the range of temperature during which crystals are melting. When all the crystals are melted, the rate of rise of temperature will again be accelerated. Now it is an assumption well justified by known facts that the temperatures at which these crystals melt are not widely different from those at which they crystallize from their vitreous solution—*i.e.* from the cooling glass. The range of retardation found during heating may therefore be regarded as defining the "danger zone" during which risk of crystallization exists, and may thus serve to indicate the range of temperature through which the glass must be cooled as rapidly as possible by some form of "chilling."

While the achievements of the Continental makers of optical glass make it clear that in regard to many valuable glasses which more or less closely approach these extreme types the numerous and serious special difficulties have been overcome, yet the fact remains clearly evident that there does exist a very well-defined limit to the possible range of glasses. A glance through the most extensive lists of optical glasses yet produced at once brings out the fact that the available values of the optical constants all lie between relatively narrow limits. Thus the refractive index (n_D) lies between 1·46 and 1·90, and the value of the constant ν ranges from 67 to 29. The question naturally

presents itself whether these limits are fixed and inevitable, or whether there is any prospect of exceeding them to a marked extent. From the point of view of optics, it is obvious that a much wider range in both constants would be of immense value, opening up possibilities in optical design not at present contemplated as even remotely practicable.

To some extent the facts just discussed in regard to the special difficulties which arise with those glasses which may be regarded as "extreme" in type serve as evidence for the view that the limits of optical properties for glass, as found in modern trade lists, cannot be greatly exceeded—for reasons of a chemical and physical character intimately bound up with the very nature of the vitreous condition. The conclusion is at all events probable that extreme optical properties are correlated with physical and chemical characteristics which tend so strongly to promote crystallization that the retention of the material in the vitreous condition becomes impracticable. If this is the case we must look for optical media whose properties transcend those of glass among crystalline substances. The practice of optics has actually taken this step in at least one very important case. I refer to the use of the mineral fluorite in the best microscope objectives. This mineral has a refractive index of 1·4338 and a ν value of 95·4, thus lying, in both respects, well outside the limits attainable in the case of glass. In this striking instance we have a verification of the view that such extreme optical constants are only attained by crystalline material, and an examination of the optical constants of many other minerals at once confirms this view. Thus the garnets possess refractive indices ranging up to 1·81, while in some of the spinels this constant attains the very high value of 2·096. Determinations of the ν values of these minerals are not available, but no doubt a correspondingly wide range would be found.

The general conclusion would thus seem to be justified that for an extension of the range of available optical constants we must look to crystalline transparent minerals. Unfortunately, there are very few minerals which can be satisfactorily employed for optical purposes. The great majority of these substances, as found in Nature, are more or less deeply coloured, and, moreover, their occurrence in large homogeneous and transparent pieces is rare; consequently their use for any but the smallest lenses is prohibitive on account of the cost. A further and fundamental limitation arises from the fact that the great majority of minerals are doubly refracting to a more or less marked degree, and this property renders their use in general impracticable. Thus at the present time fluorite and rock crystal (quartz) are probably the only minerals employed in the shape of lenses, although calcite is used for Nicol prisms and rock salt has been employed for special purposes.

The state of affairs just indicated, however, should not, in my opinion, deter us from the project of extending the range of our optical media by the utilization of crystalline materials. A considerable number of minerals are known which are free from double refraction—*i.e.* those crystallizing in the regular system, and the whole question resolves itself into the problem of obtaining crystals of these substances in sufficiently large sizes and of sufficient clearness and purity to be useful for optical purposes. As I pointed out in a paper on "Possible Directions of Progress in Optical Glass," presented to the Optical Convention of 1905, the problem of the artificial production of crystals of the size and quality required, although offering many difficulties, would not appear to lie beyond the range of possible practical solution. I still strongly hold the view that with adequate resources used in the light of modern knowledge of the process of crystallization, research on the question of the synthetic production of such crystalline material offers considerable promise of success. In a small way, and without any considerable expenditure of time or resources, I have made some experiments in the production of mineral crystals by means of diffusion processes, and these have yielded quite promising results. For an investigator approaching this subject with adequate resources, a very wide and promising field lies open.

Leaving these fascinating speculations on possible future developments, we may rapidly summarise the whole position in regard to the manufacture of optical glass.

The account of the process which has been given in these lectures, although far from complete, has perhaps been sufficient to convince the reader that optical glass manufacture is at once one of the most interesting and one of the most difficult of manufacturing operations. Indeed, were it not that optical glass is made and used in very large quantities, one would be inclined to take too serious a view of the numerous difficulties and obstacles and to imagine that the entire process was impracticable

as a commercial undertaking. To some extent this is probably a correct conclusion, as there is some reason to doubt whether optical glass manufacture by itself has ever been conducted as a profitable industry. Since, however, bitter experience has made it clear that this branch of glass manufacture is one of the most important "key" industries, it becomes clear that in one way or another the industry must be stimulated and maintained in this country. The possibility of accomplishing this end by what might be termed "political" means, such as the granting of subsidies or the erection of tariff walls, has already been suggested. On the other hand such devices can at best be regarded only as necessary evils—there is no real inherent reason why optical glass should not be made as well and as economically here as in Germany. The actual causes which have led up to the position as it existed before the war are fairly well known; it is one of those cases where a lead on both the scientific-technical and the business side was once gained and has subsequently been steadily maintained. The point of view which I would wish to urge is that the prospect of making good this lee-way by simply following upon the lines which they have struck out is not very bright. What is, in my opinion, required, is that we should strike out for ourselves in order to place the whole industry on a more rational and scientific basis. The existing process is in so many ways unsatisfactory and uneconomical that possibilities of radical improvement must exist in many directions; some of these I have tried to indicate in these lectures. If by a combination of extensive research conducted under the best conditions and with the aid of ample funds, with subsequent business enterprise and manufacturing skill, such a forward step can be achieved, then the leadership in this branch of industry may be restored to us, and we shall not need subsidies or tariffs to enable us to face the competition of those who are now our enemies—and that, surely, is the real goal to be aimed at. Fortunately the Government has already shown its appreciation of the necessity for research in this subject by making substantial grants for the purpose both to the National Physical Laboratory and to the Glass Committee of the Institute of Chemistry. Researches at these places are well in hand and are already yielding promising results—although the final goal is yet far ahead. The effort, however, is being made, and we have every reason to look forward with hope to the ultimate result.

ENGINEERING NOTES.

The Longest Tunnel in North America.—This, says the *Engineer*, is on the line of the Canadian Pacific Railway Company, and is being driven through the Selkirk Mountains in British Columbia, passing under Mount Macdonald. When finished the tunnel will be exactly 26,400 ft. or five miles long, and it will be longer than any tunnel in North America by three-quarters of a mile. It is on a new line constructed between Beavermouth and Cambie, and between the eightieth and ninetieth mile-posts west of Field. The old line which is being supplanted has some extremely heavy gradients; indeed, there are no less than 22·15 miles of 1 in 45 gradient in a total length of less than 30 miles. Moreover, the maximum elevation reached is as much as 4,330 ft., and the route traversed by the line is such that in the region of the summit there are no less than four miles of snow sheds. The new line will reduce the length between the two places mentioned by about 4½ miles; there will only be 6·61 miles of maximum gradient of 1 in 45; the greatest elevation reached will be only 3,791 ft.; the use of snow sheds will no longer be necessary; the total curvature will be much reduced, several loops being altogether done away with. These very important improvements are not, of course, being effected without considerable expense; it is said, in fact, that some £2,400,000 are being laid out on them; but the saving in running costs which will be realised will be very great, for not only will less locomotive power be required to carry on the same traffic, but there will not be the same trouble in keeping the line free from snow during the winter. The tunnel is to be 24 ft. high and 29 ft. in greatest width. Save for something under 400 yards at each end, where the material traversed consists of clay and boulders, the boring is through mica schist and quartzite rock. In the latter portion there is to be no lining, but for the softer materials a concrete lining is being used. The greatest depth of rock above the tunnel is very nearly 5,700 ft. A feature in the boring of the tunnel is the employment of what is termed a "pioneer bore," which is a subsidiary heading driven parallel to the centre line of the main tunnel at a distance, for the major portion of its length, of some 45 ft. from that centre line. This subsidiary tunnel measures 7 ft. by 8 ft. in cross-section, and from it, at intervals of something over a quarter of a mile, cross galleries are driven in the direction of the axis of the main tunnel, and when this axis is reached the main borings are begun in both directions. The tunnel, therefore, is being bored from a number of faces at the same time, boring also proceeding from the two portals simultaneously. The method of boring employed is first of all to run a heading 8 ft. by 11 ft. on the centre line

of the tunnel, and to excavate out to full section from that heading. Generally speaking, the grade of the "pioneer bore" is 10 ft. above the sub-grade of the main tunnel, but the eastern portal is 53 ft. above grade and the western portal 135 ft. above. The cost of driving this "pioneer" bore was naturally heavy, but as the railway company is paying a premium on every day saved on the contract time, and as the subsidiary tunnel has very materially hastened and cheapened the construction of the main tunnel, the contractor fully anticipates that the result will be that the money laid out will be more than counterbalanced by the savings effected and the bonus earned. Work on the undertaking was only begun in June, 1914, but it is anticipated that it will be completed in September of this year.

Port of London Improvements.—The Port of London is now and has been for some time past free from congestion. To-day all is working smoothly, and ships arriving in the port discharge and load without delay. One of the improvements is the widening and deepening of the entrance to the East India Import Dock. The entrance, which was built to meet the requirements of the old East Indiaman, was so narrow and of such a shape that the dock was inaccessible to anything larger than a 500- or 600-ton steamer; now it can be used by steamers of 8,000 tons. Other improvements include the construction of new two-story sheds at the London (Western) Dock, the enlargement of the sheds at the West India Dock, and the provision of new sheds at the South-West India Dock. The greatest of the improvements in the programme, the new Albert Dock extension, which is to cost £2,000,000, has not yet been finished owing to difficulty in obtaining machinery for the dock gates. Including this and the works completed or still in hand, the total outlay on improving the dock and dredging the river is estimated at £6,000,000. It is noteworthy that, in spite of the cost of these improvements, the Port Authority have not raised their charges beyond the 15 per cent. required to cover the two war bonuses they have had to pay. The Port Authority are now employing from 7,500 to 8,000 men daily, against a normal number of from 4,500 to 5,000, and the number of men employed by the shipowners and other interests in the port has probably increased in the same proportion.

Portland Cement: Attributes of its Constituents.—The major constituents of Portland cement are tricalcic silicate, dicalcic silicate, and tricalcic aluminate. Of these constituents, according to a statement made by George A. Rankin in a paper on Portland cement in the *Journal of the Franklin Institute*, the compound tricalcic silicate is the one which hardens and develops the greatest strength within a reasonable time. This most important constituent, which is the one formed with the greatest difficulty, makes up only about 30 to 35 per cent. of an average normal Portland cement. It may be said, therefore, that the essential process for the manufacture of Portland cement is the formation of this compound, and that any improvement in this process yielding an increased percentage of tricalcic silicate will increase the cementing value of Portland cement. In order to determine the most economical process for producing tricalcic silicate in the highest percentages, it will be necessary to study the rate of formation of this compound in a series of mixtures of various substances; this, in turn, necessitates the determination of the equilibrium relations of tricalcic silicate at high temperatures in such mixtures. Such a procedure will lead sooner to the discovery of the optimum composition in various cases and for various purposes than the empirical trial-and-error methods that have hitherto prevailed.

The London Postal Tube Railway.—Information just conveyed to Parliament by Mr. Asquith in a written answer that the tunnel was nearly completed, is to the effect that the purpose of the railway is to accelerate the transmission of mails and parcels and reduce the expenditure on road vans, incidentally relieving congestion in the streets. Starting at Paddington, it runs almost due east past the Western District Post Office to the Western Central District Office, where it turns in a north-easterly direction to Mount Pleasant. Then it takes a south-easterly direction as far as the General Post Office in Newgate Street, continuing thence almost due east past Broad Street and Liverpool Street stations to the Eastern District Post Office in Whitechapel. Its total length is about 6½ miles, and its depth below the surface varies from 28 ft. to 37 ft. Between stations there is a single tunnel, 9 ft. in diameter, containing two tracks of 2-ft. gauge, but at stations separate tunnels of larger diameter are arranged for the up and down lines, with space between them to give accommodation for lifts, shoots, and control cabins. No drivers will be carried on the trains, which will be driven electrically and worked on a distant-control system. The steel trucks carrying the parcels and mails can attain a speed of 35 miles per hour, but 25 will probably be nearer the average. At busy times of the day it will be possible to run trains at one-minute intervals. The whole system works automatically on the lines perfected by the British and Colonial Pneumatic Tube and Transport Company, as far as the electrical undertaking is concerned. The present line will ultimately connect all the main post offices in London, and also provide postal tube communication with the railway termini.

Locomotives for New South Wales.—The Assistant Minister for Railways, Mr. Hoyle, states that the Government has, through the Railway Commissioners, signed a contract with the Clyde Engineering Co., Auburn, near Sydney, for the construction of 300 locomotives, covering a period of five years, beginning April, 1917. He said recently that "The Clyde Engineering Company, being the lowest tenderers, have not only a very large order, but they have agreed to extend their plant, which will enable them to get out sixty engines per year—more than one per week. They will begin by increasing their output, and long before the expiration of the term of five years they will be turning out the sixty engines per year. At present the company's output is about one per fortnight. We consider this to be an excellent arrangement, and one of the first substantial efforts to make the Empire self-contained. We are launching a locomotive building industry here which will be the start of one of the largest of its kind in Australia. I have always had a strong desire to build up our industrial greatness, and this is the first result of efforts in that direction."

NOTES ON BOOKS.

Electrical Apparatus-making for Beginners. By Albert V. Ballhatchet. London: Percival Marshall & Co. 2*s*. net.

This little book has been designed as a guide to the beginner in making electrical apparatus, and to help him to proceed in a definite path, and with more method than is usually to be found in the very young student. After a preliminary chapter on the choice of tools and materials—and it is remarkable with what simple appliances a clever lad can produce workmanlike results—the author describes a variety of apparatus, ranging from the simplest cells to such complicated mechanisms as telephones and voltmeters. The instructions given are clear, and should be easily followed by any intelligent boy, while the plans should be of very material assistance when he comes to the actual making of the instruments.

Town-planning in Ancient Dekkan. By C. P. Venkatarama Ayyar, M.A., L.T. Madras: Law Printing House.

The squalor and ugliness of many of our cities have led, during recent years, to a crusade of town-planning in this country, while the scheme to create a new capital in Delhi has given rise to a similar development in India, whither, by the way, a considerable number of our enthusiasts have betaken themselves in order to assist in the movement. Town-planning, then, may be said to be very much in the air at present, and any good literature on the subject may be sure of finding a public. Mr. Venkatarama Ayyar has in this little volume devoted his attention to a particularly interesting branch of the question. India—and Southern India in particular—was, at no very distant date, one of the greatest city-making regions of the world, and the author has carefully studied the town-planning lore of the Tamil Shastras—a task for which, as Reader in Dravidian Philology in the University of Madras, he is singularly well equipped. From these sources he now presents us with full and excellent accounts of Madura, Vanji, Conjeeveram, and Kāvērippumpattinam, and these descriptions are followed by chapters on striking features of Indian town-planning, such as typical houses, the manram, or the open space in villages and towns, and the garden village.

It seems clear that ancient Indian cities were carefully planned, and were laid out with a view to securing the best possible sanitary conditions and the general convenience of the inhabitants; and the author concludes that a critical study of the older Tamil literature, which is a faithful record of the history and civilisation of the ancient Dekkan, would prove of great benefit to the future town-planner.

Trade as a Science. By Ernest J. P. Benn. London: Jarrold & Sons. 2*s*. 6*d*. net.

It is not perhaps the worst feature of this little book that it is provocative. Most readers will agree with a great deal of it; they will almost certainly disagree with a good deal more; and that will give them to think, which is no bad result for any book to boast.

The work falls into three sections: in the first the present position is sketched; the second puts forth a tentative scheme for the organisation of a Ministry of Commerce, and a system of official trade associations; while the third describes the more important branches of work awaiting the attention of the trades of the nation.

Mr. Benn has a good many faults to find with the British tradesman (which term he uses to cover "manufacturers, merchants, bankers, and all directly associated with trade"). He is unprogressive, narrow-minded, jealous of his trade secrets; "he is not even concerned with the welfare of his own trade as a whole, but confines his entire attention to the immediate problems of his particular establishment." If these charges are true, the author should hardly be surprised or indignant at the attitude which he alleges the public adopt towards business. As a matter of fact, we think he is quite out of date in both his criticisms: nowadays there are plenty of broad-minded and thoroughly progressive men of business, and there must certainly be very few fools left who would allege that brewing is about the only trade a gentleman can enter.

On the other hand, there is no doubt still room for a great deal of improvement in the British business world, and it is true, as Mr. Benn says, that "the discipline of war has prepared the way

for the organisation of trade, and there is now every hope that a far better state of things from this point of view will exist in the future." Whether all the good anticipated by him will result from the establishment of his Ministry of Commerce may perhaps be doubted; but the present state of things verges on the grotesque. Mr. Benn certainly scores a point when he relates how a deputation recently "waited upon the Prime Minister to present to him certain resolutions passed at a meeting of the Guildhall, London, to consider trade after the war. The deputation consisted of two Lord Mayors, two Sheriffs, three members of the House of Lords, one accountant, and Sir George Alexander."

On another point, it seems to us, Mr. Benn's zeal is greater than his discretion. He resents the attitude of our higher educational authorities towards business and commerce, and in particular he criticises the University of Cambridge (presumably he means the Cambridge University Press) for publishing in an industrial and commercial series of books for boys a general preface in which occur the words, "Industrial and commercial prosperity does not, in itself, constitute greatness, but it is a condition without which national greatness is impossible." One would have thought the worst that could have been said about this sentence was that it was a trifle trite and obvious, but to Mr. Benn "it discloses the hopeless and regrettable attitude of those who are shaping our most precious raw material." Possibly, if he had made further inquiries, he would have been surprised to find how much work the University of Cambridge has been doing for a good many years past to secure the proper co-ordination of science and industry, and to provide first-class men to fill important positions in the business world.

Although we have picked out one or two points for criticism, we readily admit that the book is none the worse for being provocative. It contains a great deal that is useful and stimulating, and it is to be hoped that it will be widely read by those who are interested in the future of British trade.

GENERAL NOTES.

PRODUCTION OF CYDER IN FRANCE.—The production of cyder in France last year, according to the latest published official returns, amounted to 22,942,000 hectolitres (304,724,044 gallons), or nearly 3,000,000 hectolitres (66,000,000 gallons) less than in 1913. Last year the quantity of apples and pears used for the making of cyder and perry, as well as for distilling purposes, was 44,824,000 quintals (4,411,811 English tons), as compared with 46,614,000 quintals (4,587,992 tons) in 1913, of which 2,094,000 quintals (206,102 tons) were exported, chiefly to Germany or Switzerland. Last year the export of apples for cyder-making was nil.

BRITISH FINANCE.—Speaking in the House of Commons on the 10th inst., Mr. McKenna gave some striking figures relating to our financial position. On the assumption that the war would continue until March 31st next, he estimated as follows:—

Total indebtedness	£3,440,000,000
Advances to Allies and Dominions	800,000,000
Net indebtedness	2,640,000,000
National Income, about . . .	2,500,000,000
Or, perhaps	2,600,000,000
Capital wealth	15,000,000,000

Mr. McKenna gave a batch of other figures to show how the war had been financed during the first four months of the financial year. They may be summarised as follows:—

Treasury Bills, increased by .	£275,000,000
Exchequer Bonds	154,000,000
War Expenditure Certificates . .	16,000,000
War Savings Certificates . . .	13,750,000
Paid off . . . . of 3 months securities.	46,000,000
Received in actual revenue . . .	100,000,000

A NEW FIBRE PLANT.—Attention is drawn by the *Textile Mercury* to the "malva blanca," a plant grown in Cuba, as a very promising source of fibre. The producers claim that they can grow and ship it profitably for less than 1½*d*. per lb. with their present crude methods, and that with proper machinery and equipment this figure could be materially reduced. The persons engaged in the industry apparently hope to supply the 20 million sugar sacks required annually in Cuba, and they are credited with the statement that 2½-lb. bags of malva fibre can be placed in the market at from 3½*d*. to 5*d*. each. It is said that malva fibre has about the same textile strength as Dacca jute, and that its fineness is between that of jute and flax.

ZOOLOGICAL SURVEY OF INDIA.—The details are now published of the Government of India scheme for the constitution of a Zoological Survey of India. The project has been approved by the Secretary of State, and the additional cost involved by it will, it is intimated, amount to about Rs. 3,300 a year. In recommending the creation of the Zoological Survey to the Secretary of State the Government pointed out that "since medicine, more especially tropical medicine, is intimately connected with certain branches of zoology, it is obvious that anything that furthers the interests of zoological research in this country will indirectly benefit medicine and sanitation materially." Attention was also directed to the fact that interest in Indian zoology has largely increased in recent years. The scheme as finally sanctioned provides that the headquarters of the Survey shall be the Indian Museum. The first Director will be Dr. Annandale, the present Superintendent of the Zoological and Anthropological Section, and the staff and establishment of the Section will be taken over by the Survey.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

EXAMINATIONS.

The results of the Intermediate (Stage II.) Examinations, held from May 29th to June 7th last, were posted to the centres concerned on the 18th inst., and those in the Elementary Stage were issued on the 24th inst. A printed list of results of the combined examinations is in course of preparation and will be published next month.

PROCEEDINGS OF THE SOCIETY.

FOTHERGILL LECTURES.

HISTORIC BUILDINGS IN THE WESTERN WAR ZONE: THEIR BEAUTY AND THEIR RUIN.

By the Rev. G. Herbert West, D.D., A.R.I.B.A.,

Author of "Gothic Architecture in England and France."

Lecture I.—Delivered February 7th, 1916.

BELGIUM.

Wordsworth forgot the Netherlands when he wrote—

Two voices are there, one is of the sea,
One of the mountains, each a mighty voice.
In both from age to age thou didst rejoice,
They were thy chosen music—Liberty.

There is a third voice; for as these low-lying plains, outcast of earth and ocean, are the result of stubborn conflict with the angry sea, so the genius of liberty has always inspired their inhabitants with as noble a spirit of resistance to oppression as ever it did the English or the Swiss. The words inscribed on the group of the Nervii at Antwerp in memory of their resistance to Cæsar, "Courage and Patriotism," have been the motto by birthright of the Flemish race all through their chequered history.

But the whole tribe of the Nervii was destroyed by Cæsar, and the modern Belgians are a mixed race, chiefly of two stocks—Teutonic Flemings in the north, Celto-Latin Walloons round Liége and in the Valley of the Meuse. Three famous figures in the first Crusade, which was largely a Belgian enterprise, may represent for us the three chief qualities of a rather complex national character—intense religious devotion, courageous noble-hearted chivalry, too great a love for the material delights of life.

We see the first in a Walloon monk, Peter the Hermit, who for two years wandered over Europe mounted on a mule, carrying a crucifix and preaching the First Crusade; the second in Godfrey de Bouillon, so called from his brave defence of his mother's castle of Bouillon when he was only seventeen, one of the most courageous, noble, and devout men that ever lived. Robert II., Count of Flanders, represents the third type. He would have been made King of Jerusalem before Godfrey, but refused to stand, saying, "I promised the Countess my wife to return to her on fulfilling my vow. It is a very long time since I had either a hot or a cold bath, or slept between white sheets, and it is well known how accustomed the Flemings are to good living, comfortable beds and warm houses."

But why in this flat, featureless land did cities arise, and where shall we look for them? In Roman times Flanders was a forest-clad, almost unknown corner of the world; but with Charles the Great it became the great trade-centre of his empire, and towns sprang up at the head of gulfs, like Bruges; on an estuary, like Antwerp; where a great road crosses a river, Maestricht, Valenciennes; where two rivers meet, Liége, Malines, Ghent; where a river ceases to be navigable and boats must therefore be unloaded, Ypres, Brussels, Louvain, Douai; and these will all be trading cities whose members will form guilds or trades unions for the protection of their own special industry.

Now what may we expect to be the chief buildings of a city? The account in the Book of Genesis of the building of the first city will tell us. The builders of Babel said: "Go to, let us build us a city and a tower." There you have the history of the beginning of all municipal art with a tower as the first building in a city. It is the first mark of the independence of a community, whether on the banks of the Euphrates, the Po, or the Scheldt. A watch tower, a place of refuge, whence the people might be called together to defend themselves, was the most valued possession granted in early charters to a city. Whether in Italy or Flanders, the belfry tower was the sign of the freedom and power of the community, and its height was in proportion to their greatness. Then came the church, and lastly the town hall, the meeting-place of the town council. But in Flanders, where the cities began as associations of traders, the market house, or meeting-place of the merchant guilds, or of the chief of them, that of the cloth weavers, comes earlier, and is more important than the town hall, attaches itself to the belfry, and even puts itself in front of and hides the church as it did at Ypres, which both in its buildings and its history was the earliest and remained the most typical of Flemish towns.

Note the position of the three buildings at Ypres. The centre of the Cloth Hall is the ancient belfry tower, which dated from 1201 and replaced a much older wooden one. The wings, east and west, forming a front 437 ft. long, were built on at different times as trade increased. The whole was completed by 1304, but always on the original design. The Town Hall, or Nieu Werke, was not built till 1620, but the old plans made in 1575 were those followed. This adhering to the original design, century after century, is one great characteristic of Belgian art. Consequently the latest buildings often appear to be far older than they really are.

The River Yperlee ran at first uncovered in front of the Cloth Hall and boats could unload directly into the open colonnade, the closing of the arches of which destroyed much of its original character. The original entrance was at the east end. Not until the merchant guilds had lost their power, and the town had become an ordinary municipality, was the Town Hall built in front of it.

Till 1383 Ypres was the chief seat of the cloth industry, but in that year there were rival Popes. Ypres supported the one at Avignon in France, the men of Ghent the one at Rome and they besieged Ypres, with English help under the leadership of the Bishop of Norwich. The inhabitants had anticipated modern warfare and barbed-wire entanglements by surrounding their city with an impenetrable barrier of thorn bushes. In memory of this successful device they put a statue in the Cathedral to Our Lady of the Thornbushes, or of the enclosures, and the first Sunday in August was Thorn Day. Alas! it is never likely to be kept again, for it was the very day of the declaration of war. The suburbs where the workmen dwelt were destroyed in the siege of Ypres and never restored, and as the city was besieged five times afterwards, one can only wonder that so much was left for the Huns to destroy.

The Cathedral, hidden behind the Cloth Hall, was a beautiful church, but with nothing very remarkable about it outside or in except the tower which was very fine. The exterior, as is frequently the case in Belgium, was unfinished; the interior had the usual simple cylindrical columns, characteristic of most Flemish churches, which show that they never seized the great principle of Gothic architecture—vertical continuity. The towns became wealthy too late for them to work out a style of their own, as the French and the English did; so they generally took the style of their churches ready-made from France, and they are usually internally of a somewhat uninteresting uniform type, with high narrow lancet windows. But during the fourteenth and fifteenth centuries rich benefactors delighted to make the furniture of the churches and the accessories of worship as splendid as possible. Nowhere was this better seen than in St. Martin of Ypres, where the chimes, the glass, the stalls, the confessionals, the font, the pulpit, were of the most splendid description. The only thing lacking there was a fine rood screen, such as we shall see in other churches, as at Lierre, where the screen, still, we hope, existing, is almost precisely like that of Dixmude, now destroyed. The stalls in particular were of the greatest beauty. Belgium has always been famous for its woodcarvers, and one of the very best of them was Urbain Taillebert, who carved these stalls and the still more famous choir screen at Dixmude. The pulpit, the work of two monks, and called the "Pulpit of Truth," was more astonishing than beautiful; but the copper screen, with alabaster statuettes, which enclosed one of the chapels was a delicate and exquisite work of seventeenth century art.

It is a pathetic ending to our account of

Ypres to quote the guide-book description of it before the war: "The strong seventeenth century fortifications were destroyed in 1852, and nowadays everything is very quiet and unwarlike. The bastions and lunettes, casemates and moats which spread in every direction round the town have disappeared, and those parts of the fortifications which remain have been turned into ornamental walks; a sleepy country town with clean well-kept streets, dull and uninteresting save for the Cloth Hall, which stands a silent memorial to the past." Now it is the home of desolation; the only living things left there are the rats that scamper over the heaps of stones which form the tomb of the glory that was Ypres.

The thirteenth and fourteenth centuries were a constant struggle by the free cities, especially Bruges, against the efforts of the kings of France to annex their country. In 1302 Philippe le Bel entered the city at the invitation of the Lilymen, or French party, who put into prison the two leaders of the Lion's Clawmen or Clauverts, De Coninck and Breidel. But they escaped, entered the city from opposite sides by night on May 31st, and in the morning slew all the French garrison, testing them, like Jepthah, by the shibboleth of "Schilt ende Vriendt"—shield and friend. This was the "Matins of Bruges." Next year a great French army came up against a small force of Flemish peasants outside Courtrai. As at Bannockburn twelve years later, the peasants dug pits covered with brushwood in front of their lines, and in the early morning a priest passed down the ranks blessing them, and each man raised a sod of earth to his lips and swore to die for his Fatherland—a lesson which they have never forgotten since. Archers formed the front line of the French army, and were winning the day till the French knights, shouting that they would not have common men win the battle for them, charged right over their own troops till they were brought up against a thin red line of men of Ypres, dressed in their own scarlet cloth and armed with thick sticks with an iron head, which were ever after called "Goeden Daegs"—Good Mornings—from the welcome which they gave to each knight as they cracked his skull. It was the first modern battle in which, as a little later at Crécy, a poorly equipped voluntary army, fighting for freedom, proved itself more than a match for the "mailed fist" and "shining armour" of the professional soldier. May the omen once again prove true! Such was the slaughter that it was called the Battle of the Spurs, from the hundreds hung up in the Cathedral. The French in their flight sacked and burned the town, as the Germans did Senlis the other day, and the town hall had to be rebuilt. There are, therefore, no very old buildings in the place. The great fifteenth century chimney-piece in the council chamber is the most interesting thing.

Though at this time Ghent stood aloof from the other two *bonnes villes*, Ypres and Bruges, it was on the whole the most patriotic of the three, and shortly after this, under the leadership of a remarkable man, Jacques van Artevelde, made an alliance with our Edward III. On the demand of his suzerain Philippe le Bel, who was fighting the English in Aquitaine, the Count of Flanders, Louis de Nevers, had had all the English in Flanders interned—the first instance, I believe, of that proceeding. So Edward stopped the export of English wool to Flanders. But that ruined the English sheep farmers as well as the Flemish weavers, numbers of whom came over to Norfolk and founded our English clothing trade. It was to put an end to this ruin of the two countries that Edward came over to help Van Artevelde against the King of France. But Philippe was undoubtedly the suzerain of the Flemings, who could not therefore legally fight against him. Edward, therefore, put forward his absurd claim to the French crown, so that the Flemings might be able to say that they were fighting for their true overlord the King of England, who claimed to be the rightful King of France, against a false claimant, the king actually in possession of the French throne.

With Ghent, therefore, are connected the beginning of our long Hundred Years' War with France, the origin of our woollen manufactures, and what matters most of all to us now, our first great naval victory. For though Edward's army did nothing in Flanders, owing to the murder of Van Artevelde, which put an end to the alliance and made him transfer operations to France—where six years later he won the battle of Crécy in 1346—yet his fleet of 300 ships and 4,000 men completely destroyed the French fleet of 800 ships and 35,000 men at Sluys near Zeebrugge in June 1340. The French, who were all crowded together, were suddenly attacked in the harbour by the English, who sailed in on the flow of the tide. The English archers poured in showers of arrows and then boarded, as at Trafalgar. The English lost only two ships, and 30,000 Frenchmen were drowned. No one dared to tell the French king of the disaster till

his jester said: "Oh, the English are cowards, they really are. Why, they didn't even dare to jump into the sea to save themselves as our brave Frenchmen did."

But it was not the military weakness of the people that made the record of the struggle with France one of almost unbroken defeat, but the trade rivalry of Ghent and Bruges. It was the opposition of the boatmen of Ghent to the people of Bruges making a canal to the sea, when their port of Damme was beginning to silt up, that made the latter bring Ghent to the verge of starvation by stopping all food supplies, till Philip van Artevelde, the son of the murdered Jacques, having watched all night on the top of the church tower, came down and roused them to action, saying—

Death opens every door
And sits in every chamber by himself.
If what might feed a sparrow should suffice
For soldiers' meals, ye have not wherewithal
To linger out three days. For corn, there's none,
A mouse imprisoned in your granaries
Were starved to death.*

So they set the great bell Roland ringing in the belfry, and, by a sudden assault against the gate of Bruges, took the city and destroyed the walls. That was in January 1382. But in November the French came, and Van Artevelde was defeated and slain at Roosebek, near Roulers, just where we have been fighting. Yet this disastrous battle, which laid Flanders at the mercy of France, had one good result—the common misery put an end to the enmity between Bruges and Ghent.

Two years later, by the marriage of the heiress of the Count, Louis de Maele, Flanders passed into the hands of the Duke of Burgundy, Philippe le Hardi, and so became absolutely dependent on France. Philippe had been taken prisoner at Poitiers, together with John, King of France, by Edward III., who gave him his name of le Hardi, or the Cheeky, because at a banquet in London he protested against Edward, the vassal, being served before John, his suzerain.

Philippe le Hardi and his two successors, who were harsh and cruel but wise rulers, crushed Flanders into one. The third Duke, Philippe, miscalled Le Bon, England's ally against France till 1435, starved out Bruges till 24,000 had died of hunger and defeated the men of Ghent under the walls of Audenarde, killing 20,000 of them.

But until then Bruges had been at the summit of her prosperity, and indeed she soon recovered, and in spite of all these troubles flourished exceedingly and was the centre of the commerce of the world. There were more than fifty great guilds, and the merchants of seventeen kingdoms had their palaces within her walls. Sadly few of them have survived, but for 600 years the famous belfry has watched over the rise, the glory and the fall of the city.

In 1280 a fire destroyed the old wooden belfry of the ninth century, and the two lower stories are very like Ypres. Too like—Bruges must have a higher tower than Ypres, to match with her greater glory. So stage by stage was added, till, beautiful as it is, it is out of all proportion to the Cloth Hall, which it crowns. As a whole, the building is far inferior to Ypres, though the interior courtyard is very picturesque. The Town Hall (begun 1376) is quite a small building by the side of it; its statues were gilded by H. Hubert van Eyck. All the streets are full of the relics of ancient splendour, but sadly shorn of their pristine beauty. One of the prettiest things is the late Gothic porch of the Church of Notre Dame, beside which is seen what is left of the house of Louis of Grunthuise, one of the most splendid of the merchants of Bruges. He was a self-made man who rose to be Knight and Treasurer of the Order of the Golden Fleece, and intimate friend of Edward IV., who took refuge with him when driven from England, and created him Earl of Winchester. He was the patron of William Caxton, who was himself Governor of the English "nation" in the city.

If the fourth Duke of Burgundy, Charles the Bold—or as he is better called, the Rash—had not deserved his name by his mad folly, he might have formed a strong united nation able to withstand the attacks of France. As it was, he undid all that had been done, and played the Kaiser to his father's Bismarck. Much of his most ruinous work was done in Hainault, to the cities on the Meuse, Huy, Dinant and Liége. These had never been industrial towns, and the Guild of the Copperworkers of Dinant was the only powerful one. On the whole, they had lived quietly under the somewhat patriarchal government of their Prince Bishop. But the people of Dinant and Liége, whose industries were becoming important, were beginning to be restless and turbulent.

By the machinations of Louis XI. Liége and Dinant were incited to revolt against their Bishop, Louis of Bourbon, nephew of Philippe le Bon. The people of Dinant hated the people of Bouvignes on the other side of the Meuse, and hanged an envoy whom they sent across, and

* Sir H. Taylor, "Philip Van Artevelde."

put up a dummy of Charles with a placard, "Tell your old mummy of a Duke to go home again. Louis of France is coming to help us." Then Bouvignes fired a dummy of Louis XI. across to Dinant from a catapult. The Dinantais refused to apologise, but instead had a parody of the "Joyeuse Entrée" of Charles. So Charles, with an immense artillery of very heavy guns, besieged and took the city almost at once. It was a surprise to the world very like that of the fall of Liége and Namur in 1914. The Liégeois were sending help, but it came too late, as some other help did in 1915. Dinant was sacked and utterly destroyed; 800 citizens were tied back to back and thrown into the river, others were thrown from the cliffs. But no outrages on women were allowed, and all offenders were hung in sight of the army. Charles has been beaten in barbarity by the Kaiser (August 28th–30th, 1466). Next year Charles entered Liége through the wall which was thrown down for him, and fined the city 115,000,000 florins and tortured nine chief citizens to death. Shortly after, acting on a false report that the Liégeois had killed their Bishop, he came again, bringing with him Louis XI., whose promise of help was the cause of all the trouble. He took the city in a week, and asked Louis what he should do. Louis replied: "My father was troubled with rooks. He destroyed the nests three times, but they built again, so he had the tree cut down." Charles then systematically burned the town and killed all the inhabitants. The few who escaped were being still hunted down in the woods three months after. His general, Antoine de Loisey, writing from Liége, says: "We don't trouble about justice. We just hang or burn anyone we come across. The city has been so utterly wrecked that there is not a scrap of paper left to write on. I had to tear this from an old book." There was therefore nothing old left in Dinant when the Huns destroyed it last year; but in Liége the Bishop rebuilt his palace in 1508. That and the Church of St. Jacques were the only important old buildings in the huge manufacturing city which Liége was before the war.

In 1477 Charles was defeated and killed at Nancy by what he called "the contemptible little army" of Swiss tailors and cobblers, and his body was found two days afterwards, half eaten by wolves, in a frozen ditch.

Louis XI. at once treacherously laid siege to Arras, and, in spite of the piteous appeals of his goddaughter—Mary of Burgundy, Charles's heiress—took it and completely sacked it. Consequently, as might be expected, very few houses older than the fifteenth century were left.

Mary of Burgundy died just after she had married Maximilian, King of the Romans, afterwards Emperor. Maximilian soon got into money troubles with the people of Ghent and Bruges. The latter, discovering that he had sent for an army from Germany, kept him prisoner in 1487 for eleven weeks in the Craenenberg, the windows of which they fitted with bars, for which the bills still exist. All his German followers were executed one by one, except one who escaped, disguised as a peasant woman carrying a basket of onions. They might have spared all the others, if only they had hanged that one, for he was the Count of Zollern, ancestor of the Kaiser.

In 1497 Maximilian's son Philip was married to Joan, the heiress of Spain, at Lierre, in front of its beautiful choir screen. In 1506 Philip died and poor Joan went mad with grief. Margaret of Austria, her husband's sister, became Regent till the infant Charles V. was of age. He was the most powerful monarch of his time, and no king has ever held so many titles, but failing health made him long for release from the burden of empire. There never probably was any scene more striking in the world's history than that which took place on October 25th, 1555, in the Hall of the Golden Fleece in Brussels. Crippled with gout, leaning on the shoulder of William of Orange (the Silent), he told the story of his reign, confessed his faults, and begged forgiveness of any he had wronged, and then placing his hands on his son's head, gave him his blessing and sank back sobbing in his chair, while all the audience were moved to tears. He went to live in a small house in Brussels for a year, and then retired to the Monastery of St. Juste in Spain, where he filled his rooms with clocks and watches which he tried in vain to make keep time, and when he failed he said: "All my life I have been trying to make men work together and I can't even make clocks do it." He indulged in one even more impressive ceremony, his own funeral Mass, which he had carried out as if he had been inside the coffin which stood in front of him.

Time would fail if we tried to give any account of the horrible persecution of the Protestants carried out by his mean and cold-blooded son Philip. It is fully told in the fascinating pages of Motley's histories.

The chief adviser of the Regent, who was Philip's half-sister, Margaret of Parma, was Cardinal Granvelle, Archbishop of Malines,

whose tyranny roused the three chief nobles who had so far been on Philip's side, to send a letter protesting against it. They were Count Egmont, who had greatly distinguished himself in the battles of Gravelines, and of St. Quentin on St. Laurence's Day, 1557, when by his strategy the French army was practically annihilated, and Philip, in his joy, had ordered the building of the Escurial. The other two signatories were Count Horn and William the Silent, Prince of Orange, the greatest man of the three. Philip, on receipt of the letter, sent the Duke of Alva to be Governor of the Netherlands with orders to arrest and execute Egmont, Horn and William within twenty-four hours of his arrival. William at once took refuge in Holland, and Egmont said to him, "Farewell, landless Prince," to which William replied, "Farewell, headless Count!" Counts Egmont and Horn were executed in front of the guild house of the Cross-bowmen (Maison du Roi) at Brussels, June 5th, 1568. The building was greatly damaged in the bombardment by Louis XIV., and rebuilt in the style of that time. It has been recently restored according to the original design, so it is said, but all the character and history have been taken out of it, as so often happens with restorations. Four years later, Alva all but seized William by a night attack, in which he was saved by his little spaniel, who, hearing strange footsteps, woke his master by scratching his face and barking. Alva wreaked his vengeance on Mons and Malines, both of which he sacked, and the horrors perpetrated in the latter town would have been incredible if they had not been surpassed to-day. But even Alva did not wreak his vengeance on churches. It was reserved for the Germans to destroy the Cathedral and its wonderful tower of St. Rombauld, which was begun in 1452, but discontinued after the sack when it had reached only 320 ft. out of the 544 ft. which Jan Kelderman had intended it to have. The town hall was never finished from the same cause.

But Malines was not the only town which the Spaniards sacked. In 1576 for three days Antwerp was given over to what is still known as the Spanish Fury. More than 6,000 men, women, and children were butchered and 800 houses burnt. Antwerp had risen into importance when the silting up of the Zwyn had caused the decay of Bruges in the early fifteen hundreds, and consequently there are no very important buildings of a much earlier date. Also Antwerp suffered more than any other city from the image-breaking of the Calvinists in 1566. The Cathedral especially had been wrecked by them. It had been begun in 1352, and the tower had been carried as high as the first gallery by 1440. At the end of the sixteenth century the Keldermans planned a magnificent cathedral, but had only finished one tower when a fire destroyed all the material which they had collected and the funds had to be used for the rebuilding. The Town Hall, which is a fine specimen of the late Flemish style from which our Jacobean was derived, was built in 1561.

But let us return to Brussels. Comparatively little remains of the Brussels which saw the execution of Egmont and Horn, except the Town Hall, which is the finest of all the town halls in Belgium. Brussels had never been a manufacturing city like Ghent and Bruges, so its town hall was from the first really a town hall, not the abode of the guilds or four *nations* who arose much later at Brussels than elsewhere. The guilds had their separate houses which, picturesque as they are, date only from the beginning of the eighteenth century. They are those of the mercers, shippers, archers, carpenters, printers, and bakers. The town hall was begun in 1402, and by the middle of the century the east wing and tower were finished. The tower then stood as an angle tower on the north-west corner. The architect Van den Berg is said to have thrown himself from the top of the tower in 1431, because he found out then that he had not put it in the middle of the façade, but as the tower had not then been begun and the east wing was not finished till 1486, the legend lacks foundation. Some of the work is of the sixteen hundreds, more of the seventeens, after the bombardment. It was from Brussels and Louvain, with their constant repetition of similar bays, that Sir Charles Barry got his inspiration for the Houses of Parliament. Let us, therefore, now look at Louvain town hall, the only building which the Huns have left in that once beautiful city. The architect, Matt. de Layens, was appointed in 1448, on the death of John Kelderman, with a salary of thirty gold florins and enough cloth to make him a dress suit. He was to follow in the main the design of the Brussels Town Hall, which then consisted of only one wing and had no tower. Louvain was to surpass Brussels, and so it did, and perhaps that is why Brussels finished her tower and added another wing. "And yet one cannot but feel as one stands before this fascinating and fantastic structure with its crowd of statues, its dainty corbels, its

bristling roof and filigree niches, its pinnacles soaring to heaven like crystallised incense smoke, that it is less the triumph of the mason than of the sculptor; that architecture has ceased to reign; and that one of her handmaids has usurped her place." This is the character of all the late civic buildings of Belgium. And it is the more striking when we look at the churches, which are singularly plain in the interior as well as in the exteriors, which are hardly ever finished. To be fair, let us look at the Cathedral of St. Gudule. Nothing really is known of the saint, who is said to have lived about A.D. 712. Even her German biographer who wrote in 1047 tells nothing, because, with unusual candour, he says he thinks it a holier thing to keep silence than to tell lies—an opinion not shared by his descendants. It is a disappointing building, the exterior cold and dry with hard vertical lines; not for a moment can one think of it in the same line as Paris or Reims, or even Abbeville. The chancel dates from 1273; the nave was finished by 1446, and the towers by the beginning of the fifteen hundreds. The finest thing in the church is the late Renaissance work, and especially the stained glass. Nearly all the windows contain portraits of the later rulers of Brabant, and most of them were designed by Bernard van Orley.

Of the other buildings of Brussels, about the most interesting is the Church of Notre Dame du Sablon. It was originally, and indeed is still, the Chapel of the Guild of the Crossbowmen, the one guild which still survives in Brussels. The Calvinists would have destroyed it, but when they found it full of crossbowmen they retired, after relieving their feelings, according to the manner of crowds, by howling outside. It was begun in 1419, and took more than a century to build, but, as usual, the original plans were kept to throughout.

The chief cause of there being less to see in Brussels than in most of the other towns of Brabant is not only that, like them, it rose to importance at a later date than the Flemish towns, but that it was almost destroyed by Louis XIV., who bombarded it in 1695 with red-hot bullets and destroyed sixteen churches and over four thousand houses. He was in many respects the prototype of the Kaiser, and we English may take courage from the thought that though for fifty-two years he had never lost a battle nor failed to take a fortress, it was our William III., who had never till then won a battle nor taken a fortress, who in that year, by taking Namur, checked the career of that would-be world conqueror. It was in revenge for Namur that Louis bombarded Brussels—a truly Hunnish proceeding both in its barbarity and its utter futility, but less vile than the burning of Louvain.

But let us, before we leave the Brussels which he ruined as the Germans have ruined Louvain, go, as all tourists do, to Waterloo, and there, standing on the Lion Mount and gazing back over the history and the battlefields of Belgium, gain for ourselves an unswerving confidence in the justice of Him who ruleth over the kingdom of men and giveth it to whomsoever He will. Never yet has it been seized for long by a would-be world conqueror. All the nations of the world, not only the Jews, have been people chosen to carry out some work for Him—and time after time the work set to England has been to destroy the power of the Nebuchadnezzars of the modern world, not that she may ape their pride, but may learn the humility which they were taught—Philip II. and the Duke of Parma in the Armada; Louis XIV. at Namur and Audenarde; Napoleon at Waterloo—always on the battlefields of Belgium. Let us then, standing there, take good courage for the Future from the Past.

TRADE OF THE BAHREIN ISLANDS, 1915.

The statistics regarding movements of pearls and specie are very incomplete, as numbers of local pearl merchants, who travel to and from Bombay, and the foreign pearl merchants, carry large quantities of pearls and specie in their luggage or on their persons. There is no bank in Bahrein, and many lakhs of rupees are brought in every year by registered post in the form of Indian currency notes of 1,000 or 500 rupees. It is, of course, impossible to obtain statistics of all these sums. The effects of the upheaval in Europe began to be felt in Bahrein even before the commencement of hostilities. The pearl dealers, somewhat dazzled by the high prices ruling in 1912, in which year the catch had netted over £2,000,000, had been inclined to hold up their stocks for higher prices in 1913. The scale of living had also risen, and the commencement of the pearl season of 1914 found them with large stocks, but heavily indebted. The European pearl dealers who arrived in Bahrein Ramazan just before the Ramazan break in the fishing, were not inclined to pay high prices, and little business had been done when telegrams were received ordering them to cease buying owing to the strained relations between the Great Powers. As was natural, the depression affected most severely the improvident lower orders who depend on the pearl trade. The trade of the Bahrein Islands is to

a great extent in the hands of Hindu, Indian Mohammedan, and Persian merchants, who have been settled in these islands for a century, and thus by far the greater part of the trade is with India. Messrs. Gray, Paul & Co., the British India agents, are the only British firm. The one German firm in Bahrein has been closed. Shipping and communications have been naturally greatly upset by the war, and the Hamburg-Amerika line has, of course, ceased to run. Only 62 vessels entered the port during the year against 89 in the previous year. The total value of imports into Bahrein amounted to £758,418, as against £1,877,630, showing a decrease of £1,119,212, or 59·6 per cent. As has been already noted, the greatest decreases were in pearls and specie owing to the collapse of the European pearl market. The import of rice also fell by over 50 per cent. This was due during the early part of the war to the difficulty of the shipping, and latterly to capital being called in by Indian firms with branches in Bahrein.

The total value of exports fell from £1,740,008 to £461,624, a decrease of 73·4 per cent. It must be noted that, as exports are sent by native boats, no accurate statistics are available. The decreases are due to restrictions of markets owing to the war.

A SILK CAMP.

The *Pioneer Mail* has received the following from the Salvation Army headquarters at Simla:—

Perhaps the only mulberry forest in the world is to be found at Changa Manga, near Lahore. It is some 10,000 acres in extent, and has hitherto only been used for purposes of fuel and timber. It demonstrates that mulberry can be profitably grown by Government and private individuals for fuel and timber purposes, apart altogether from its great value in providing food for silkworms.

Some months ago Commissioner Booth Tucker asked the permission of the Punjab Government to take advantage of the immense supply of foliage in this forest to establish an annual silk camp during the months of February and March for the rearing of silkworms on a large scale, with a view to popularising the industry throughout the Punjab and other parts of India, and in order to demonstrate the best methods for rearing silkworms. The Lieutenant-Governor expressed his cordial approval of the scheme, and five acres have been assigned within the forest for the purposes of the silk camp.

Operations were commenced early in January, when a party was sent in advance to make the preliminary arrangements for erecting sheds and preparing accommodation for some two to three million silkworms.

As far back as May, 1915, a supply of disease-free eggs of the best varieties had been ordered from Europe. They reached the Simla Silk School in October, and were there hibernated in a special machine provided for the purpose.

This preparation for the silkworm industry is of recent introduction, but is an important link in the successful rearing of the best varieties. It helps to ensure a vigorous race of worms, which will produce cocoons rich in silk, and also protects them from disease.

Special hatching machines of a simple pattern have been utilised by the Salvation Army during the last three or four years. The use of these and their value for hatching purposes will be demonstrated. They insure uniform heat, and enable the eggs to hatch out simultaneously, thus avoiding much trouble, delay, and loss of eggs from chills.

Different systems will be demonstrated in the silk camp. The two chief dangers to be guarded against are excessive heat and excessive cold, with violent variation between the two. The various systems will be demonstrated, and the students, workers, and visitors will be allowed to judge for themselves which they consider best, or which will be most suitable for their own locality.

One large shed has been prepared on a system which guards both against cold and excessive heat. This has been introduced with great success at the Salvation Army silk farm at Moradabad. A trench is made about 100 ft. long, 12 ft. broad, and 3 ft. deep. The excavated earth makes a wall about 3 ft. high, with a thick thatched roof, and a doorway at each end. In a dugout of this character worms have been successfully reared in the hot weather.

The Persian system of a shed on poles raised above ground, where the air can freely percolate all round, and leaves can be stored underneath to get rid of extra moisture when there has been heavy rainfall, will also be demonstrated.

In Japan and Europe it is usual to rear the silkworms on shelves, carefully arranged, tier on tier. This economises space and gives the worms the best individual care. In Kashmir, and most parts of India, the worms are usually reared upon the ground, branchlets of mulberry twigs being heaped on top of each other. This ensures economy of labour, an important consideration. Instead of six or seven feedings during the twenty-four hours only two are necessary, morning and evening. The respective advantages of both systems will be demonstrated.

Besides the large sheds for the hatching of the worms, there are more than fifty tents for the accommodation of the workers and the staff, and for lectures and demonstration. The camp is already a hive of industry, with about 100 workers. It is intended to increase the number to 150, as the worms increase in size and need more attention.

GREECE (ZANTE).

The British Vice-Consul at Zante, writing with reference to the import trade of that island, states that even in so small a place as Zante there are indications that German traders are already making preparations to

resume business operations and to retrieve their position in trade, as soon as the war is over. It may not be amiss, therefore, for British traders to be advised to take the necessary steps to forestall this competition, and they should bear in mind that German exporters will spare no pains or expense in order to secure the desired object.

Prior to the war, imports from the United Kingdom into Zante had been gradually giving way before German competition. This was due to the energy and attractive methods of the German trader, such as extended terms of payment, rebates regulated according to the position of clients, advice as to selection, prompt despatch of goods to Zante, quotation of c.i.f. prices, and other facilities to which buyers all over Greece are now habituated.

With the exception of codfish, pickled fish and salmon, herrings, unwrought iron, sulphate of copper, soda ash, some textiles and yarns, etc., which are of British origin, most of the imports into Zante came from Germany and Austria. Imports from these latter countries comprised cutlery, hardware, glassware, enamelled ware, crockery, cotton and woollen manufactures, leather goods, lamps of all kinds, stationery and paper, domestic and household requisites, toys, dyes, drugs, medicines, brushes of all descriptions, etc.

If United Kingdom manufacturers will adapt their methods to the requirements of the Greek market, there is no reason why they should not secure the greater part of the trade in the goods hitherto supplied by Germany and Austria as soon as the war is over: a great advantage in their favour is the admitted superiority of British goods of all kinds.

RESOURCES OF THE SUNGPAN DISTRICT OF CHINA.

Sungpan is situated in the extreme north-western part of the Szechwan Province on the Min River very near to its source. While its population is about 4,000, it is an important distributing point for the Kokonor region of north-eastern Tibet and the border country north and north-west of Sungpan.

Sungpan as a commercial outlet for the region which it taps is most favourably situated. Not only can its exports be conveniently shipped by the Min River to Kwanhsien and thence to Chengtu, the provincial capital, but goods which are destined for Chungking and which eventually reach Shanghai and foreign countries enjoy the exceptional transportation facilities afforded by the Yangtze River and an important tributary that passes through Lunganfu, Tungchwan, and Hochow, and has its source near Sungpan.

The principal exports from Sungpan are sheepskins, wool, medicines, musk, fur, and hides. These are chiefly exchanged for tea, rice, and Chinese wine. Tea, which is largely consumed by the Tibetans and aboriginal tribes adjacent to the Sungpan district, is the principal article of import. The rice and Chinese wine are consumed by the comparatively small Chinese population of this region.

Most of the tea that figures in this trade is grown in the vicinity of Kwanhsien and Anhsien. The tea is of inferior quality; but since the beverage made from it usually contains butter, and the butter is very often rancid, the flavour of the tea is decidedly of secondary importance. Cheapness is the great desideratum. This requirement is successfully met, for the tea sells at Sungpan for less than 2*d.* per pound. Not only do the Tibetans use tea in making a beverage, but they also use it in preparing their principal article of food, which contains butter, salt and barley meal as well. This dish is known as "tsamba," and is generally consumed throughout Tibet.

Large quantities of the wool, medicines, musk, and hides from Sungpan finally reach the hands of foreign buyers. The wool is of somewhat inferior quality, and is used in the manufacture of carpets. Neither the quality nor the quantity of musk is equal to that obtained at Tachienlu. Medicines are the distinguishing feature of the trade of Sungpan; the most important from this district which are known to foreign markets are aconite, liquorice, and rhubarb. Many other herbs are employed for medicinal purposes, but they are mainly consumed in China.

According to a report by the United States Consul at Chungking, it is impossible to determine the value of the products which reach China by way of Sungpan. Mr. E. H. Wilson, the eminent naturalist who visited Sungpan on several occasions, estimated that this trade in 1910 amounted to about £120,000. However, since the commerce of Sungpan has considerably increased during recent years, it is probable that this figure represents only a part of the present trade.

The Sungpan district is poor agriculturally. The country is dry and mountainous and the few crops that are raised are very meagre. Wheat, oats, maize, barley, buckwheat, peas, beans, and Irish potatoes are grown to a certain extent. The area of cultivation, however, does not extend beyond an altitude of 12,000 ft. From 8,000 ft. to 10,500 ft., according to Mr. Wilson, represents the wheat-growing belt, while barley and buckwheat can be raised at a much higher altitude.

The country is not at all favourable to the cultivation of rice, this cereal, so highly prized by the Chinese, being imported into Sungpan for their use, as already mentioned. Most of the fruits that thrive in the north temperate zone are found in the vicinity of Sungpan, and some of them, particularly plums and peaches, are of

excellent quality. A fair variety of vegetables is also produced, and the potatoes, peas, and carrots compare favourably with similar vegetables in foreign countries.

There are few settled agriculturists or traders in the Sungpan district. Most of the people lead pastoral lives and many are nomadic. Their principal wealth consists of cattle, horses, and sheep. As the country is well adapted to raising these animals, there are great possibilities in this direction. The Chinese are beginning to realise this, and are trying to improve the breeds which they now have. They are already sending American sheep for this purpose to Sungpan, and hope to have a better quality of both wool and mutton.

With improved stock and the excellent grazing which the country affords, there is a good opportunity, in the opinion of the United States Consul, for the development of a large dairying industry. It is probable that this will be undertaken soon by the Chinese authorities at Chengtu, who are much interested in the industrial possibilities of the north-western part of the Szechwan Province. The future prosperity of Sungpan will no doubt depend in large degree upon the extent to which the pasture lands are utilised in producing an augmented quantity and a better quality of wool, hides, meat, butter, cheese, and other animal products, which could figure much more prominently than they do in the export trade of the district.

TRADE OF AUSTRALIA IN 1915.

In his report on the trade of Australia for 1915, H.M. Trade Commissioner in Australia (Mr. G. T. Milne) states that during the earlier part of the year the greater part of the country was still suffering from widespread drought. But when the long-looked-for rains arrived they were fairly general in character, and the resulting improvement in the pastures and crops brightened the outlook in all States with the exception of Queensland, which, having escaped in a large degree from drought when the rest of the country was suffering, was itself destined to suffer later. There was also a considerable area in New South Wales still affected by dry conditions till late in the year, but towards its close matters improved both in Queensland and in the parts of New South Wales alluded to. As a result of the abundant rainfall, there has been far more "feed" in many districts throughout Australia than could be used, the flocks and herds having become so seriously depleted in numbers. It is estimated that, owing to drought, the losses of sheep and lambs will exceed 15,000,000 in number, while the losses of cattle, including dairy stock, have also been serious. The situation will be reflected in the returns from the wool-growing industry, it being expected that there will be a diminution of 500,000 bales in the current season's clip, while there will also be a falling-off in the amount of meat available for export. High prices for these commodities will afford pastoralists partial compensation for their losses. The brightest feature both in retrospect and prospect is the wheat harvest, which is estimated to yield from 150,000,000 to 160,000,000 bushels—a figure about 50 per cent. in excess of any previous harvest. Over 100,000,000 bushels will be available for export, but the difficulty of procuring tonnage makes it doubtful whether the total crop can be shipped this year.

The effect of the war has been shown in various ways. The wealth of the community has been manifested in the extraordinarily generous contributions made to the various patriotic funds for which subscription lists were opened. Money is, of course, dearer, the cost of living is higher — this leading in turn to demands for increased wages—while taxation has increased. The withdrawal from their ordinary pursuits of the large numbers of men who joined the Australian Expeditionary Forces has affected the labour market to some extent. The heavy expenditure of loan money for war purposes has led to great activity in such local industries as were affected by the demand for equipment for the Expeditionary Forces. The diminution in the volume of the imports must be regarded as a reflection of the conditions created by the drought, as well as of those obtaining in the London money market, in consequence of which less loan money was available for expenditure on public works. The shortage of tonnage and consequent high freights are also war factors affecting both the export and import trades.

According to a statement in the Melbourne press towards the end of October, freight rates on most goods imported from the United Kingdom and the United States had increased by anything from 44 per cent. to 80 per cent. since the commencement of the war, and in the case of timber from Baltic ports the rates then operating had expanded by 180 per cent. For cased merchandise, such as soft goods, silk and apparel, rates by mail steamers to Melbourne increased from 70*s.* to 110*s.* per ton. It is estimated that the extra freights paid on 813,635 tons of merchandise from overseas imported into Melbourne between January and August of last year averaged 22*s.* 6*d.* per ton, and that the total amount of the increase passed on to the public was between £900,000 and £1,000,000.

Import Trade.—Preliminary figures put the total value of the import trade, inclusive of specie and bullion, during the year ended June 30th, 1915, at £64,431,837, as compared with £77,254,653 during the calendar year 1913. The value of the imports of "competitive merchandise" from all countries was £48,867,011, of which £31,732,974 represented imports from the

United Kingdom, £1,899,075 imports from British Possessions, and £7,430,170 imports from the United States.

Export Trade.—The value of the exports, inclusive of specie and bullion (£2,907,666), during the year ended June 30th, 1915, was £60,600,302, as against £78,571,769 in the calendar year 1913, the falling-off being due to the severe drought and to the dislocation of the wool and base metal industries and of shipping, owing to the war. Wool exports in 1915 amounted in value to £22,088,309.

Mining.—The decline in the gold production of the Commonwealth continued last year, the total output according to statistics furnished by the Mines Department (with the exception of Tasmania, for which the output is estimated) aggregating 1,942,835 fine oz., as against 2,048,905 oz. in 1914. As regards lead and zinc concentrates, mine owners have experienced considerable difficulty in disposing of their output of concentrates owing to the closure of the Continental markets for these metals, but of late large shipments have been made to American smelters, while Japanese buyers have also secured several shipments. Exports of coal from Newcastle, N.S.W., to other States and overseas during the calendar year 1915 amounted to 4,006,177 tons, valued at £2,108,057, as against 4,743,505 tons, valued at £2,488,449, for the corresponding period in the previous year.—*Board of Trade Journal.*

MATÉ, "TEA" PRODUCTION IN SOUTHERN BRAZIL.

Yerba maté, or Paraguay tea, constitutes one of the sources of wealth in Southern Brazil. It is the largest article of export from Parana and one of the largest from Rio Grande do Sul and Santa Catharina. The principal markets are Argentina, Uruguay, Chile, Paraguay, and Bolivia, in the order mentioned. In these countries maté is the popular drink of the people, almost to the exclusion of coffee and tea. It is supposed to have two great advantages over either coffee or tea—it is less stimulating and very much cheaper.

The maté tree is between 10 and 12 ft. in height, the leaves resembling those of a pear-tree. The grades of maté depend upon the amount of wood in the leaf. The following are the classifications: No. 1 maté, from Paraguay; No. 2, from Matto Grosso; No. 3, from Missoes Argentinas; No. 4, from Parana; No. 5, from Rio Grande and Santa Catharina.

According to a report by the United States Consul at São Paulo, the total consumption of maté in Argentina alone amounts to 50,000 tons annually, of which Parana furnishes 18,000 tons and Santa Catharina, 2,000 tons annually. Exact statistics are not available. The total exportation to all countries in 1913 was:—

Exporting State.	Amount.	Value.
	Tons.	£.
Parana	49,538	1,591,000
Santa Catharina	3,793	63,100
Rio Grande do Sul	2,174	139,700
Total	55,505	1,793,800

The exportations from Santa Catharina have fallen off very greatly during the past ten years, and the quality of the tea is not as good as that of the Parana maté.

Maté is prepared in the same way as tea, and may be taken with sugar and milk. In powder it is prepared by infusion, putting it into a small vessel (a *cuia*) and pouring thereon a sufficient amount of boiling water. As the dust does not sink to the bottom of the vessel the maté can be taken only by means of a "sucker"—that is, a tube terminating in a small hollow ball pierced with holes. Travellers to Argentina have doubtless noticed many quaint maté pots, of silver and other metals, lavishly ornamented.

The Germans in Curityba (the capital of the State of Parana) prepare it in the following manner. They heat the water, and when it is boiling add the maté. When the water begins to boil again they pour in a sufficient amount of cold water to stop the boiling. The dust then settles and the maté is taken pure.

The component parts of maté, compared with tea and coffee, as prepared by Dr. Caminhoa, Professor of the Faculty of Medicine at Rio de Janeiro, are as follows:—

In 1,000 parts.	Green Tea.	Black Tea.	Coffee.	Maté.
Essential oil	7·90	6·00	0·41	0·01
Chlorophyl	22·20	18·14	13·66	62·00
Resin	22·20	36·40	13·66	20·69
Tannin	178·00	128·80	16·39	12·28
Theine or caffeine	4·30	4·60	2·66	2·50
Extract and colouring matter	464·00	390·00	270·67	238·83
Fibers and cellulose	175·80	283·20	174·83	180·00
Ash	85·60	54·40	25·61	38·10

COCONUT CULTIVATION IN MALAYA.

In view of the rapidly-growing demand for copra and the produce of oil-yielding nuts of every description for the home manufacture of margarine and for other commercial purposes, any check to the growth of these nuts within the British Empire is to be deprecated.

Prices for copra during 1915 were 20 per cent. higher in the Singapore market than in 1914, yet the annual report of the Planters' Association of Malaya states that "during the year under review few extensions have been undertaken either by Europeans or natives. Natives (and in some cases Europeans) have been busy cutting out their coconuts to make room for the more attractive cultivation of rubber, which at the present time must needs claim the greater attention and capital." That the Government of the Federated Malay States is fully alive to the danger of limiting the forms of cultivation in their territory is borne out by the comments of Mr. E. S. Hose, Acting Director of Agriculture, in his report for 1915. In the Klang district of Selangor certain estates have been cutting out coconut trees in order to allow interplanted rubber trees to develop. On many small holdings also good bearing coconut trees have been cut out in order that rubber might be planted. "This practice on the part of small owners is highly inadvisable," writes Mr. Hose, "and the sub-inspectors of coconuts in Selangor have been instructed to persuade the owners to abandon it, if they can. During inspection work in Pahang it was observed that in many cases, especially in the Kuala Lipis district, no young trees had been planted for many years in the old kampongs to take the place of the very old trees which are gradually dying out. It is desirable that the importance of planting up young trees should be impressed on the owners. In addition, it appeared that more attention should be paid to manuring and cultivating the trees and to keeping newly-planted trees free from lalang."

The Malay States are especially favourable for coconut cultivation. During 1915 the growth of the trees in the coastal parts of Perak and Selangor was very satisfactory. Most trees commence flowering in the fifth year and bear nuts in the sixth. On one estate a 3½-year-old tree produced 550 nuts. In the second half of the year the crop of nuts on estates all over the Federated Malay States was short. There was a general belief that this was attributable to the absence of sunshine, as, though the rainfall had not been above the average, it was assumed (in the absence of scientific corroboration) that there had been a large percentage of cloudy days. It was considered that the nuts were present on the trees, but had not ripened.

The acreage under coconuts in the Federated Malay States on estates over 100 acres in extent was 54,822 against 58,027 in 1914. Appended is a comparison of the exports of copra for the past five years:—

	Tons.	Value.
1911	8,039	£151,000
1912	7,710	152,036
1913	9,347	211,042
1914	14,499	288,545
1915	13,937	214,492

Excluding the Straits Settlements (the statistics for which were not available when the report was compiled), but including the other Malay States under British protection, the acreage under coconuts on estates over 100 acres in extent was 82,250, Kelantan and Kedah having 18,201, Johore 1,621, and Trengganu 7,606.

In his report Mr. Hose sets out in detail the measures adopted by his Department for detecting and combating various beetle and ant pests attacking the coconut palms. The Chief Agricultural Inspector reported that rats were troublesome in Krian, Perak, and were also harmful around Sabak Bernam. In the Bagan Datoh district they were kept well under control and little harm was done. The Assistant Inspector of Coconut Plantations went to this district to supervise the destruction of the rats. Two thousand traps were issued to the Kampong owners, and a reward of c.1 per tail was offered. In addition 250 traps were lent to the manager of one estate. All the estates used traps and employed tin shields for young trees to some extent. On estates 206,375 rats, and on kampongs 34,196, making a total of 240,571, were destroyed between May 5th and the end of the year. This result was deemed satisfactory.

The Agricultural Department is engaged on experiments for the better cultivation of the coconut palm in Malaya. There is no doubt that valuable results might be obtained from a study of the various kinds of nuts, their yields, and the yields of artificial hybrids of the first generation.—*London and China Telegraph.*

COTTON IN RUSSIA.

According to the "Explanatory Memorandum" of the Russian Minister of Finance attached to the draft Budget of the Empire for 1916, there has been a remarkable increase in the cotton-growing and cotton-spinning and weaving industries of Russia during recent years. It is estimated that the 1915–16 crop of pure cotton fibre in Russia will be 18,750,000 poods (1,000 poods equal about 16 tons), as compared with 13,055,000 poods in 1912–13. The cotton grown in Russia, however, together with that imported from Persia, Afghanistan, and Kashgar, only meets about two-thirds of the requirements of Russian cotton-mills, and the balance is imported mainly from the United States and Egypt.

With regard to the cotton-spinning industry in Russia, the number of spindles in operation

in 1914 was 9,112,000, as compared with 8,950,000 in 1913, 7,350,683 in 1905, and 6,645,559 in 1900.

The development of the cotton-weaving industry has also been rapid. In 1900 the estimated number of looms in Russia was 151,306. By 1905 this figure had risen to 178,506; in 1910 it was 213,179; and in 1912 it was 224,411.

The output of textiles amounted to 19,589,229 poods in 1913, as compared with 12,520,495 poods in 1905, and 11,703,667 poods in 1900. As a result of the increased output of cotton textiles in Russia, there has been a reduction in imports of foreign goods.

NOTES ON BOOKS.

Welfare Work. By E. Dorothea Proud, B.A. (Adel.). With a foreword by the Right Hon. David Lloyd George, M.P. London: G. Bell & Sons, Ltd. 7*s.* 6*d.* net.

Although it is true, as Mr. Lloyd George says in the preface to this volume, that "Welfare Supervision is no new thing, either in this country, in the Dominions, or in America," still the conditions of labour in Great Britain during the last two years have been such that this matter has now acquired a fresh and striking importance. The sudden advent into munition works of men of all descriptions, and still more of women—many of them utterly unaccustomed to factory conditions—produced a great number of difficult and often delicate problems, and so necessary did it become to find a satisfactory solution of these, that a new Department was created at the Ministry itself, "charged with the general responsibility of securing a high standard of conditions for all workers in munition factories." Miss Proud has served in this Department since its creation, but, as her book was completed some time ago, it does not touch upon the work of the Department, but deals entirely with her experiences of factories under peace conditions in Australia, New Zealand, England, and Scotland. It would, no doubt, be extremely interesting to have an account of the work carried out by the Department; but this may perhaps form the subject of another volume from Miss Proud's pen.

Whatever the abuses of the factory system, there probably have always been numbers of manufacturers who realised that not only humanitarian considerations but personal interest should lead employers to provide for the welfare of their work-people. Thus we find Dale, whose factory was the model in 1792, "giving his money by shovelfuls" to his employees only to find that "God shovelled it back again." Owen bore witness to the financial success of his philanthropic experiments at New Lanark; and in 1835 Edward Baines, whose bias was towards the masters, remarked: "I believe the conviction is strengthening and spreading that it is eminently the *interest* of a manufacturer to have a moral, sober, well-informed, healthy, and comfortable body of workmen." This sentiment would probably sound far more of a truism to-day than when it was uttered eighty years ago; for while factory legislation has done much to mitigate the harsh conditions which were imposed at the beginning of the industrial revolution, many manufacturers nowadays take pride in doing for their employees a great deal more than is required by the law of the land. By no means the least beneficial of modern departures in this direction has been the institution of welfare workers in factories, and particularly is this the case in works where women are employed. Again and again it was found that a Lady Welfare Supervisor was able to relieve the management of a mass of minor but still important detail. To quote Mr. Lloyd George again: "She heard complaints and investigated dismissals. She supervised the canteen and other accommodation. She helped to engage new labour. The character and tone of the works depended largely upon her. The foreman referred to her in matters of discipline, slack work, or bad time-keeping. The workers brought their troubles to her. The management found that her presence conduced to smooth working and increased output. She became, not only the friend of the workers, but an essential part of the business organisation. Employers and workers alike wondered how they had done without her."

These few sentences sketch in broad outline the part to be filled by the welfare worker. The details (and these are numerous, including as they do such matters as cloak-rooms, mess-rooms, rest-rooms, wages and hours, health, recreation, food, baths, and gymnasia, housing and mental development) must be studied in Miss Proud's volume. It will be found full of value, not only to employers and lady superintendents and those who propose to enter on welfare work, but also to all members of the general public who take an interest in the conditions of life in our factories.

It should be added that this book is one (and by no means the least valuable) of the excellent series of monographs by writers connected with the London School of Economics.

The Microscopy of Vegetable Foods, with Special Reference to the Detection of Adulteration and the Diagnosis of Mixtures. By Drs. Andrew L. Winton, Josef Moeller, and Kate Barber Winton. Second Edition. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. 27*s.* 6*d.* net.

Microscopical examination has come to be recognised as of the greatest value in detecting the adulteration and sophistication of foods and

drugs. The authors of this work have been identified with this movement as State and Federal officials and as independent investigators, and many of the data collected in this way are incorporated in this second edition.

The book deals first with equipment, methods, and general principles, and then proceeds to consider the microscopic characters of various products, and their chief adulterants and impurities. In this manner are described different cereals, oil seeds and oil cakes, legumes, nuts, fruit and fruit products, vegetables, alkaloidal products and their substitutes, spices and condiments, and commercial starches.

A large number of fresh illustrations have been added to the first edition, so that the present text contains no fewer than 635 figures. A bibliography is appended to each section, and the whole work concludes with a full glossary and index.

GENERAL NOTES.

Victoria and Albert Museum.—The Duke of Buccleuch has generously lent for exhibition at the Victoria and Albert Museum the well-known collection of miniatures from Montagu House, Whitehall. This collection is one of the most important private collections in Great Britain, and is rich in works by all the great English miniaturists of the sixteenth, seventeenth, and early eighteenth centuries. From the historical point of view also it is of the greatest interest, containing as it does so many authentic portraits of members of the Royal Family and of the leading men of those days. Besides the miniatures of English origin there are also included in the collection numerous examples by French and other foreign artists and a considerable number of miniatures in oil. The exhibition is arranged in Room 83, adjoining the Picture Galleries, on the first floor, and access to it may be obtained most conveniently by the staircase at the east end o the Ironwork Gallery, running parallel with the Quadrangle. The collection was opened to the public on the 22nd inst., and will remain on exhibition until further notice.

British Leather Supply.—An informal conference with representatives of the leather trade has been held at the War Office, as a result of which it is hoped steps will be taken by the Government to see that when the war ends an ample supply of leather is available. Before the war probably 80 per cent. of the upper leather came (says the *Shoe and Leather News*) from abroad, and we were flooded with German box-calf. Unless our leather producers are making the necessary preparations and perfecting the box-calf trade we shall find ourselves when the war terminates in a worse position than ever. With every desire to buy in the home market, manufacturers will be obliged to take what they can get, and purchase leather from America, or even Germany, unless our leather traders are ready with the requisite goods.

Sulphate of Ammonia.—The Board of Agriculture are informed by the Sulphate of Ammonia Association that sulphate of ammonia (24½ per cent. ammonia) will be offered for sale from now till the end of September at 15*s.* per cwt. net cash, on condition that the quantities purchased at this reduced rate are removed from sellers' works by September 30th. After that date the price for home sales of sulphate of ammonia during the 1916-17 season will be 15*s.* 6*d.* per cwt. net cash. The goods will be delivered free on rail at makers' works in makers' bags, 3*d.* per cwt. being allowed if buyers supply their own bags. Farmers are strongly recommended by the Board to take advantage of the reduced terms offered by the association, as they will thereby facilitate delivery and also secure supplies which, owing to the increased requirements of the Ministry of Munitions, may not be so easily obtainable next year. Under favourable weather and soil conditions sulphate of ammonia is a very suitable autumn manure for cereal crops. Nitrogenous manures are most effective in increasing the yield of cereal crops, and are also of great use for most other crops, especially grasses, potatoes, mangels, turnips, and cabbages. Sulphate of ammonia, which is produced in this country, is now the cheapest and most available form of nitrogen for agricultural purposes. The quantity used by farmers in the United Kingdom could be doubled with profit to themselves and advantage to the State.

Mining in Mysore.—According to the Report of the Department of Mines and Geology, Mysore State, for 1914-15, the prospects of gold-producing companies on the Kolar Goldfield are distinctly encouraging. The output of gold during the year was 568,847 oz. of the approximate value of Rs. 3,26,76,516 against 559,832 oz. of the value of Rs. 3,23,53,731 in the year before the royalty was due to the Government. The dividends declared by the companies amounted to Rs. 18,95,740 in 1914-15 against Rs. 18,95,018 in 1913-14. During the year manganese was produced chiefly in the Kumsi mines in the Shimoga district, owned by the Workington Iron and Steel Company, Limited. The ore exported amounted to 19,629 tons, yielding a royalty of Rs. 4,907, against 5,953 tons in the preceding year on which a royalty of Rs. 1,461 was realised. Work in regard to other ores, chrome, asbestos, mica, iron ore, magnesite, corumbum, clay and copper is being carried on under prospecting licences, but progress was hindered considerably by the war. There was a considerable diminution in the number of mining accidents, the mortality therefrom falling from 4·38 per 1,000 in 1913 to 2·28 per 1,000 in 1914.

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PROCEEDINGS OF THE SOCIETY.

FOTHERGILL LECTURES.

HISTORIC BUILDINGS IN THE WESTERN WAR ZONE: THEIR BEAUTY AND THEIR RUIN.

By the Rev. G. Herbert West, D.D., A.R.I.B.A.,
Author of "Gothic Architecture in England and France."

Lecture II.—Delivered February 14th, 1916.

THE CATHEDRALS OF NORTH-EASTERN FRANCE.*

When the Roman Empire fell to pieces, in most large towns the Bishop, who generally had been appointed "Defensor Populi," gradually became the sole surviving representative of law and order; and his Cathedral took the place, in the eyes of the people, of the Prætor's Basilica, as being the abode not only of the worship of God, but of justice and liberty for the poor and oppressed. And when in the early twelfth century the rise of the Communes bound the citizens finally into one, their joy and enthusiasm found visible expression in rebuilding their ancient basilica under the guidance of their bishop, and his cathedral became also the symbol of their new-born national life, the centre of all its noblest energies.

The plans of these twelfth-century buildings, therefore, while deriving from that of the basilica, show that they were meant to be not only sanctuaries, places for the celebration of the sacred mysteries, but also for the assembling together of clergy and laity for any common purpose. The building is a vast hall with a small choir, and no solid screen between clergy and people.

But in England the cathedrals tell a very different tale. In quite early Saxon times the great Benedictine monasteries of the Continent had founded missionary daughter houses in our then heathen land. And even when, after the Norman Conquest, great churches sprang up on every side, they were all in the hands of monks, generally Benedictines, and if there was a bishop he might be abbot of the monastery whose church became his cathedral. Our cathedrals, therefore, generally stand apart from the cities to which they belong, in a separate enclosure, originally fortified, in which we find them still nestling amid the elms of their quiet close. Such contrasted views as those of Chartres and Lichfield, Wells and Rouen, sum up completely the stories of the two national churches and enable us to realise how completely the French cathedral was the centre of the life of the city; how entirely the English one was detached from it.

And instead of the great assembly hall of the early French cathedral, we find in Norman England a more purely basilican plan with a single or triple apse. Then, as the churches cease to be merely abbeys and become cathedrals also, and so have to serve a double purpose, the apse is replaced, as at Lincoln, by a greatly extended choir, which with the eastern transept and chapels formed the church of the monks, with a special approach from the cloister, while the western transept with its chapels and the immense nave were the cathedral and parish church cut off from that of the monks by a heavy stone screen—almost an iconostasis, with a central door and an altar on either side. Also, since the monks did not need a public procession path in their own church round the High Altar, we do not find an ambulatory as in France, but they reverted to the Saxon square east end, and obtained their procession path in sight of the people by placing another screen westwards of the Rood screen, with a central altar and a door on each side of it, and the Rood above.

We shall also find that whereas the builders of the French cathedrals handed down as craft

* For a full treatment of the subject of this lecture see the author's "Gothic Architecture in England and France." Bell & Sons. 1911. 6s.

secrets their learning and traditions, so that the constructional development of French Gothic is the result of the severest logical reasoning from first to last, the English cathedrals were frequently built under the direction of the monks, if not actually with their own hands, as at Gloucester. There is consequently a comparative absence of scientific tradition, much less coherence in purpose and expression, but more individuality and local originality. In France traditions grow stronger and more binding, as the art falls more and more into the hands of the great guilds and becomes less and less the expression of popular feeling, till it dies stifled by the swathing bands of invariable formulæ. But English architecture—less popular at first, but freer in its efforts and expression—comes always more and more into touch with the national sentiment and finally develops an entirely new form which never really died, but, adapting itself to the social evolution of the nation, gradually ceased to be chiefly ecclesiastical, and—passing on from the cathedral and the monastery to the village church and the crenelated manor—at last, under the Tudors, gave rise to the domestic architecture of that sturdy middle class which has always been the backbone of the English nation.

Thus while France was rearing Renaissance chateaux for her luxurious nobles whose power had not been broken as in England by civil war, the English squire and his tenants, still standing side by side as at Crécy, were going on building their country houses and farms on the old lines—adding a new aisle to the parish church, raising a grammar school in the village street, or providing a college at Oxford or Cambridge to receive their boys.

The general aspect of mediæval architecture in the two countries is therefore quite different, and the difference grows greater as time goes on, for English Gothic architecture was not introduced from or dependent on France. After the introduction of the Norman style just before and at the Conquest the influence of French art on English was very slight. Now and then an isolated case of importation appears, as in the earlier part of Canterbury, inspired by, but inferior to, Sens, and in Westminster, which is entirely French in plan but English in detail; but otherwise English Gothic is purely national from the very first. Indeed, national characteristics reappear directly after the Conquest, when Norman work was largely modified by the reappearance of Saxon traditions, the square east end, the high narrow lancets, the south porch, and the great length of the nave. Indeed, the influence was rather the other way, for it seems probable that, as Monsieur Enlart has suggested, flamboyant tracery and the ogee or reversed arch were introduced by the English into France during the Hundred Years' War, when native French architecture was almost at a standstill except in the districts occupied by the English.

It is indeed the essential difference in national character which reappears in national art. The one is logical, looking to the future; the other, opportunist, living in the present. French mediæval architecture of the Royal domain passes through a process of continuous evolution from its first appearance to its final decay. It took its origin in the district of Soissons as the result of the meeting of two streams of influence, one from the east given by the noble churches of the Rhine provinces where the traditions of the great art Renaissance of Charles the Great had developed into the grandest of all the Romanesque styles; the other from Burgundy in the south, where, at Dijon and Cluny, Lombard influence had combined with the classical memories of Provence, and had passed upwards through Champagne to north-eastern France. The story is fairly clear, though some of the links are already lost and few if any will be left after the war, as the whole district is in the hands, or within reach of the guns of the Germans. The earliest of these, Tournai, is one of the noblest Romanesque buildings left. It rises strikingly above the houses on the left bank of the Scheldt, and its five central towers and two western turrets form a grand group very like that of Spires.

The round-ended transepts are a distinctly Rhenish feature, which we find reproduced at Noyon, and with an aisle and extremely beautiful detail of an almost Gothic character at Soissons, of which but little is now left. Tournai belongs to the end of the eleventh century. Noyon, which was originally an abbey in the diocese of Tournai, was begun in 1131 by Bishop Beaudoin about ten years before his intimate friend Abbé Suger began the Abbey of St. Denis; and Notre Dame of Paris, which was largely influenced by St. Denis, was begun some twenty years later, about 1160. At Noyon the Lombard influence is clearly seen in the alternation of piers supporting three vaulting ribs, and columns which carry only the intermediate rib of the sexpartite vault. The choir of St. Remy of Reims and the nave of Laon are very like Notre Dame and Soissons, the sister church of St. Remy

but some fifteen years (1180) later is already suggestive of Amiens in the columns. Through them all runs the same principle gradually unfolding itself in strict logical sequence.

In England there is nothing like the same continuous development; there is no systematic logical pursuit of one distinct scientific and artistic ideal, no distinct rise, summit and fall as in France; no single scheme of vault construction giving unity to the drama; but the story is presented, as it were, in some seven independent tableaux connected together, but shown one after another, and threaded, not on the string of a continuous scientific principle, but on that of the varying religious and social history of the nation, and presented in succession by the dominant personality of the period. The Monk comes first and builds the great Norman abbeys, then the Noble, who enshrines himself in the floriated niches of the Decorated style, and lastly the Citizen who covers his churches, like his comfortable rooms, with Perpendicular panelling. Consequently no such classification as that of the seven periods of English Gothic is possible in France, where we pass gradually step by step from the stolid Romanesque of Tournai to the restless Flamboyant of Abbeville. The only sudden break is when Flamboyant tracery is introduced by the English at Amiens during the Hundred Years' War as one of the experiments which they were always making on window, vault, and wall surface, but never allowing to become frozen into routine, always passing on to some other idea which seemed more adapted to the requirements of the moment.

Thus much as to the influence of the history and national character of the two countries on their art. Let us now turn to its constructional development in each case, beginning with France.

From the time when Christian art began to revive in the eleventh century, the efforts of all builders in the ancient Roman provinces of Western Europe were centred in the attempt to do with small materials and a limited supply of unskilled labour what the Romans themselves had never even essayed with building resources such as the world had never before seen—to make the thin and isolated walls of the three-aisled basilica, which by long use had become the recognised form for the Christian church, carry the same stone or concrete arched roof or vault as the enormously thick walls of the Romans. The difficulty was this—"an arch never sleeps," and an arched roof, or tunnel vault, is always trying to thrust down the walls which carry it. Roman vaults were of two kinds, a continuous tunnel or barrel vault—and an intersecting vault, formed by dividing the plan of the building into squares and covering each square with two short tunnel vaults at right angles to each other and crossing in the middle where they form a projecting arris or groin on each diagonal. In this intersecting vault the outward thrust of the arch is not continuous, but is all concentrated on the four corners of the square, and if they are made strong enough, or sufficiently buttressed, the spaces under the arches on the four sides need not be walled in at all. This sort of vault could be managed by these early builders on a small scale as in the low and narrow aisles of a church, but it was beyond their power to put it over the high thin walls of the nave. At last, at Durham (between 1093 and 1133), and a little later at St. Denis (1140), the idea was hit upon of building two permanent stone arches or ribs diagonally from corner to corner of each square, instead of moveable wooden centrings—and of covering in the triangles between these with rows of smaller stones arched across from rib to rib.

Then the only thing needed was to prop up sufficiently the columns or piers which carry these cross ribs at each corner of the square. This prop or buttress must be brought to bear as nearly as possible at the springing of the ribs where the thrust is greatest, or a little above it, or better at both these points. This was done at Durham and at Caen by a complete stone arch thrown across the upper gallery or triforium at the back of each pier, and better at Gloucester by a quarter arch butting against the pier. But as the nave walls had to be much higher than the roof of the triforium gallery in order to get space for the windows of the clear-story, those buttressing arches came below the springing of the ribs, which is where they are really wanted, if they were kept under the roof of the triforium. So they were raised above the roof, and at Chartres and in all the beautiful later examples, as at Amiens, are made double, so as to buttress both the springing and a point above it. Then the wall between the buttresses being useless soon gave place to a mere screen of painted glass. It was a bad principle thus to leave all the important constructional parts of the building exposed to the weather, but if one excuses that, nothing can be more perfect in beauty than the Gothic cathedral. But, as always in the work of man, only for a moment did these stern reasoners and perfect artists rest

on the summit of their achievement. Beauvais is a literal example of that "vaulting ambition that o'erleaps itself." The chiefly passive role of the buttresses of Amiens in transmitting the vault-thrust must needs be exchanged at Beauvais for an active one which shall enable the main buttresses to be smaller, and the whole building lighter, though even higher than Amiens.

But while the vault thus dictated the exterior forms of the building, it affected the interior hardly less. The monocylindrical columns with great voluted capitals were soon felt to be unsuitable and illogical, as so much of their upper surface carried nothing. So in the later columns of Notre Dame the vaulting shafts stand on the one-coursed capital of a column of their own, standing in front of the main pier. Later still the vaulting shafts are carried down to the ground and their capital is at the point where they carry their load; the springing of the aisle vault and the nave arches have their columns with capitals of one course standing on either side of, and attached to, the main column which has a capital of two courses. This progress is well seen at Soissons and Amiens. We have thus the principle of continuity distinctly formulated—that every column must have its base on the ground and its capital at the springing of its arch and only there. Soon it was felt that every colonnette should have members corresponding to the mouldings of its arch, so, by a gradual transition which may be well traced at Notre Dame de l'Epine, it came to be thought that capitals had lost their meaning and that all mouldings of all arches should run down to a common base without a break, sometimes dying into one another on the way as at St. Maclon, Rouen, but reappearing below, even if their reappearance was marked only by the corners of their imaginary bases supposed to exist inside the main pier, but to have been turned round so that their corners project from the faces of the general base.

In England the story is very different. Although we were the first to make a real Gothic ribbed vault at Durham, we never allowed the determination to have a stone roof to our churches to influence the whole design—indeed, we were quite content with an open wooden roof, which the French never were. An English cathedral is always the Norman abbey church in essentials, even when the details have become Gothic. Now the Norman church consisted of three nearly equal stories set one upon the other with little or no vertical continuity, but with the chief beauty sought in horizontal perspective as at Wells, which forms a most striking contrast to such a church as Beauvais. In France the eye is led upward at once by the vaulting shafts to the vast height of the roof; in England eastward by the pier arches along the immense length of the nave. In England the vaulting shafts hardly ever run to the ground, but stop above the nave columns, which are designed to be beautiful in themselves and not as part of a whole. They are not in various groups or sizes so as to mark distinctly their various purposes, to correspond with the arches or ribs which they represent or carry, but so as to bring in the greatest number of detached or semi-detached shafts, some of which may even have nothing to carry, and since these whenever possible were of Purbeck marble, which could only be got in short lengths, circular bands had to be introduced and the abacus of the capital became circular also instead of square as in France.

The arch mouldings indeed are even adapted to the pier, instead of the pier to the arch mouldings. These mouldings also are more deeply cut than in France and enriched, so as to be in keeping by their strong contrasts with the black and white of the columns—very beautiful and well suited to our grey climate. But when the use of marble in the piers ceased, the mouldings became shallower arrangements in grey, frequently worked on the chamfer, in striking contrast to those of late French work, which are narrow deep hollows and sharp prismatic edges to catch the light, so as to distinguish the different ribs as they run down from the vault to the ground. Again, in contrast with the French, the wall which disappears with them till the incessant vertical lines give a sense of irritating restlessness to their later styles, is in English work everywhere visible, and its restful suggestion of strength and quiet repose most grateful, while the long-drawn-out perspectives of arcades and aisles give the special character to the whole which in France is found in the soaring elevation of each separate bay.

But the real glory of our English Gothic is to be found in its latest form. I said how in French vaults the triangles between the ribs are covered in by panels made of rows of arches of small stones thrown from one rib to the other. But as the diagonal ribs are of course much longer than the arches which form the sides of the square or oblong of the vault, the stones of these little arches must be much larger at the end resting on the diagonal than at the other, and if a straight joint is to be got

along the ridge this difference must be distributed over all the little arches by carefully shaping each stone for its place in laying it. Only skilled workmen could do this properly. To the practical, rule-of-thumb Englishman it seemed much simpler to cover in his triangles with rows of stones all of the same size like planks. But the result of this was a joggle or dovetail along the ridge instead of the straight joint of the French vault. This could not support itself, but needed a rib for the ends of the stones to rest on. Also this system gave a flat surface instead of an arched one between the ribs, which if of any size needed another rib or tierceron to support it in the middle, or rather to give an extra bearing so that the rows of stones could be shorter. The effect was thought so pleasing that more intermediate ribs were added until we reach such a beautiful form as Exeter.

But a difficulty arose with these "tierceröns." They varied greatly in length, according to their position, and were all much shorter than the diagonals. Either, therefore, the ridge could not be kept level, or the curves of these ribs must be changed, "fudged," half-way. At the point where the curve changed a short crosspiece, or lierne, was put, and then as it was difficult to get a tidy-looking mitre of the mouldings, a little carved boss was placed at the intersection as at Canterbury, Lincoln and Winchester, and soon star patterns and all sorts of fanciful arrangements of the ribs were indulged in as at Tewkesbury, and the practical result became a ribbed barrel vault with intersections as in Winchester nave and Gloucester choir.

Soon the number of similar ribs springing from one capital gave the idea of making them into a perfect cone, called Fan vaulting, a very silly name. If the curve of the ribs is a single simple one, as at Gloucester, a flat ceiling must come between the cones, or if a regular vault with a ridge is wanted, the curve must be altered to provide for the different lengths of the ribs, and so the four-centred arch arose, which is characteristic of our later styles, and which naturally, as had happened previously with the pointed arch, was taken from being a mere necessity of construction to become the chief decorative feature of the building.

Having got this cone of ribs it was ingenious to bring it out from the wall and spring it from a pendant as centre, as at Oxford Cathedral, or even to bring it out so far as to complete the cone and let it meet another half cone springing from the wall as in the Divinity School, Oxford, or that final masterpiece, Henry VII.'s Chapel, so easy to criticise, so impossible not to admire. It is curious that in these latest vaults the true use of the ribs has entirely disappeared and the ribs and panels are all cut out of large blocks of stone, and we have got back to the Roman barrel vault with its continuous thrust, a strange result to arrive at from merely altering the system of covering in the triangles between the ribs. It is rendered all the more striking by the fact that the French, who kept to their original system, never arrived at these rich vaults. Many of their later vaults, as at Gisors and Abbeville, have little pendant bosses, and occasionally, as at St. Ricquier, a lierne vault may be found copied from the English ones, but anything elaborate like Rue is a mere piece of fanciful decoration.

Having now traced out the causes, historical, racial and constructional, which influenced the development of Gothic art in England and France, let us look again at the results at which the two nations arrived in their great cathedrals. There could hardly be a greater contrast than that between the two. In the exterior of the French cathedral—which is generally obviously the result of one great effort, begun with vast enthusiasm but never finished as intended, if at all—the walls have "formed fours" and are standing in slices at right angles to the building which they support but do not enclose, towering high above it, and seeming to push and thrust with all their power to keep up its enormous height. It is very wonderful and very beautiful, but leaves a sense of constant effort to overcome difficulties after all only partially vanquished. But till the other day, one cathedral—Reims—did show us almost perfectly the ideal which was aimed at and with very little of that sense of effort, standing now, alas! merely a shell, wrecked by the Huns—and the French rightly propose to leave it as it is, a monument to their enemy's eternal infamy.

How beautiful is the peace of the long low English cathedral, with its insignificant buttresses and unambitious lines, with no traceried canopies or wealth of sculpture, and, except for the upward pointing of its central spire, seeming content to remain quietly on earth; telling generally in its unequal parts and varied styles—not of a mighty impulse which faltered all too soon, of a lofty enthusiasm which died down to mere mechanical dexterity, but of successive generations of commonplace yet earnest men, each bringing its little stone and saying—

Add this to the rest.
Take it and try its worth, Here dies another day.

The French cathedral was the most perfect work of art imaginable, more complete even than the Greek temple, for not only was it a perfect combination of all the arts, architecture, painting, sculpture, more inseparable and more perfectly co-ordinated, but it was the expression of a higher, fuller ideal as coming later in the history of the human race and the work of a people as idealistic, as highly strung as the Greek. This artistic expression is found most in that part of the cathedral which was the least fully worked out, the great west front. There is not one of them which is not open to criticism as to proportion, adaptation to its purpose, disposition of lines and parts—yet there is not one which is not beautiful and inspiring.

The original type is in that strange rugged building, the Cathedral of Laon, now within the German lines, perched on its precipitous rock, fit emblem of the turbulent race who built it. The towers and triple porch, the great rose window and arcaded gallery reaching across are features which become invariable. But the point about Laon which impressed itself on the artists of that time, as we know from the sketches of Willars de Honnecourt, and through them on all subsequent buildings, and especially on Reims, was the towers. The way in which the diagonal pinnacles are carried on the angle buttresses with a rich cornice and just the right amount of horizontal lines, forms, perhaps, the best transition in existence from the towers to the spires which were to have crowned them.

There is a beautiful legend about the bold and original figures of oxen and peasants which look over the balustrades of these towers. The peasants who, as at Chartres, were dragging the stones up the hill, found the load beyond their strength, so the oxen in the fields around came of their own accord to be harnessed to the carts. In the homage given by these striking figures to the patience and strength of the docile creatures who thus helped to build the house of God, is a touching expression of gratitude and justice.

The break in the gallery is a defect avoided at Notre Dame. The horizontal lines there are, perhaps, too strong, and it is too much cut up into squares, but what restfulness in the wall spaces, what noble proportion and sense of scale! The Arc de l'Etoile is exactly the same size and looks about half. Put Wells by the side of it; the sculpture there is glorious, but is independent of the poor and monotonous design, with its mouse-holes for doors and columns like scaffold poles all over the front. Or set Amiens by the side of Lichfield with its shopful of statues put away on brackets, or even Peterborough by the side of Reims, far and away the most glorious of them all. Reims has defects and serious ones; the carrying forward of the statues round the buttresses destroys the necessary vertical lines; the towers, inspired by Laon, come out of the façade without apparent connection with it, and there is such a crowd of sculpture and galleries and fretted gables that it is not easy to understand how they are carried on the mass of colonnettes and pinnacles, open work, and carving. And not one cathedral is complete. They all lack their spires. The towers of Amiens were cut in half down the middle for lack of funds, and finished in a hurry when the first impulse had died out. Reims was set back on its ground floor and finished flimsily for the same reason. But what noble gateways to the heavenly Jerusalem as the builders of St. Ouen called their church. Never was a glorious dream more marvellously transmuted into stone than in those triple-storied portals, compassing about those passing in to worship, with so great a cloud of witnesses, and bidding them as they enter look up to Jesus, the author and finisher of their faith, their Judge that shall be at the last.

And in the interior also the story is the same. In the English church we may trace the stolid acceptance of existing facts which preserves all that has gone before, however imperfect, and, adding here and changing there, makes up a building, humble-minded as it were, with a wooden roof perhaps, content to suffice for the needs of the present, telling in every corner of the makeshifts of the past, with no sign of anxious unrealised ambition for the future, incapable of perfection because begun and ended incessantly and most often without continuous design, yet breathing out an indescribable charm of sympathy, almost human in its loving reverence for the results of all the past efforts of the bygone generations.

But in the other, the soaring lines which guide the eye upward ever to the vault of stone poised miraculously on its walls of painted glass, seem to tell of those whom

> God whispers in the ear
> For whom earth had attained to heaven—there was no more far nor near—

of those who, greatly daring in their implacable logic would sweep ruthlessly away all that had gone before, for they had dreamed to raise a structure complete and harmonious all through, the absolute expression of one over-mastering ideal of future perfection, but bound to remain

incomplete at the last from the weakness of all human means and efforts, for they had aimed

> At the high that proved too high, the heroic for earth too hard.

Yet therein lies its undying power. While our cathedrals tell of the strong consciousness of the historical continuity of the nation, which has made of the English a governing and imperial race, the mediæval architecture of France is the expression of that logical and artistic nature which has made the French through all European history the originators of the noblest social ideals, and the exponents of their highest expression in art. And here it is that the French art towers far above the English. Put Lincoln and Reims side by side. The latter seems far more the expression of the nation's soul. So far as a building only makes use of its materials dexterously, appropriately, beautifully even, with limbs and fingers only, it falls short of the highest; so far as it lays open the soul of the man or of the race, it reaches it.

Let me sum up. I have tried to bring before you not mere differences of style founded on details of moulding or tracery, things interesting but of little real importance, but to show you how English and French mediæval architecture are, each of them, the outcome of the character of the race, the result of the history of the nation, the expression of the people's faith and ideal.

The same national characteristic of "drift" for which we are paying so awful a price to-day, which has always taken us muddling along with no definite aim or plan for the future, and which led Edward III. in his blundering rush across Northern France till he was brought to bay on the hillside of Crécy, led also the workmen of his time to close their vaulting panels just any-how provided they got them closed; the same sturdy common sense and determination to stand shoulder to shoulder in whatever they undertook, which made the King dismount his knights and place them side by side with the peasants, row over row on the terraces thrown up on that gentle slope and which gave to them all when thus united the power

> to turn to flight on that famed Picard field
> Bohemia's plume and Genoa's bow and Cæsar's eagle shield;

made them also build their walls always thick enough to carry the vaults, or else rest satisfied with a wooden roof, and caused them in like manner to be content to mend and patch their heritage from the past rather than sweep it all away in the hope of replacing it by some marvel of quite unattainable perfection in the future—till in the end the gradual blending of classes and of their aspirations made itself felt in their art as in their social life, and the architecture of the cathedral, the monastery and the castle found its last expression in the village church, the manor house, and the farm. In art, as in empire, the English race has ever been the same—opportunist, realistic, almost incapable in material matters of ever formulating an aim much beyond the present moment, yet blundering half unconsciously, in spite of themselves, into marvellous results in art and empire—and, let us hope, in war.

And so with France. It was the same chivalrous devotion to an ideal which inspired St. Louis to build the Sainte Chapelle to receive the Crown of Thorns, which drove to death the knights at Crécy and Poitiers and Agincourt, which also inspired the burghers of the Communes with their wild enthusiasm for liberty and with their resolve to find for their thankfulness a visible expression in their vast cathedrals. It was the same pitiless logic and thirst for an ideal which dictated the unswerving policy of Louis XI. and of Richelieu, and which later made the nation sweep away all its past in a torrent of blood, in the vain hope of bringing back the golden age, which also in art inspired the reasoning and the artistic sense whereby the builders of St. Denis and of Chartres were led on from Notre Dame through the perfection of Amiens, the magnificence of Reims, the lovely folly of Beauvais, and the ruinous unfinished beauty of Abbeville, to the last wire-drawn skeleton of a sixteenth-century church. Through it all, up to the very end, these builders were true artists aiming at expressing a something higher than themselves which should draw up into sympathy with them all that was best and noblest in their fellow men.

And their descendants have not changed. How strikingly these characteristics are coming out in this dreadful war! What a contrast between the silent uprising and stern devotion of France, all in a moment, when the Germans were once again outside the gates of Paris, her self-consecration to the one single aim of beating back the enemy, and our vacillating, shrieking, discordant methods, culminating, however, in spite of it all, in a vague sense of national duty and purpose, which will lead us on to victory, please God, not less surely, but much less impressively than the spiritual determination of our infinitely noble and loveable Ally.

COALS AND OTHER MINERALS IN JAPAN.

By WATSON SMITH.

COAL MINES.

The existence of coal in the Miike district or thereabouts was known for many years back, as the seam crops out in one direction, and although there is no authentic record of the date when the coal was first mined, local tradition assigns the date as about the year 1468. The extent of the old workings most certainly shows that mining operations of some sort must have been carried on at a very early date, and there is positive information that before the revolution mining was systematically pursued, one part of the district having been worked by the Daimio of Miike, Lord Tachibana, and another by Ono, the chief retainer of the Daimio of Yanagawa. The coal so mined was used for salt-works on the shores of the Inland Sea and Shimabara Gulf, and is still in great request for that industry because of the great heat it easily develops owing to its highly bituminous nature, with the consequent rapid evaporation of the brine.

Of course the method of mining was of a very primitive nature, the coal having been worked from the outcrop on the side of the hill; and when the Japanese Government purchased the mine in 1873 from the then proprietors for some 40,000 yen the same simple system of mining was followed. Pumping was done only by the native tread-wheel, and draining was effected by gullies, but at the time when the Government purchased the mine, water had nearly drowned out the workings, and an immense amount of this simple pump-work had to be gone through before any quantity of coal could be mined. Convict labour alone was used for mining, and the purchase of the mine by the Government seems to have been influenced first and foremost by the object of thus finding occupation for the convicts. In 1876, the Government handed over the management of the Miike mine to Mitsui & Co., and that firm, rightly thinking that much more might be done with the mine, set vigorously to work to improve matters. They were also appointed sole agents for the sale of the coal, and under the name of the Mitsui Bussan Kaisha branch offices were opened at Shanghai and the principal Japanese ports, and subsequently sub-agencies in Hong-Kong, Singapore, etc. At the time when the Mitsui Bussan Kaisha took charge as aforesaid, the output was only some 300 tons per diem, the coal being obtained from the Oura mine, the site of the ancient workings, and carried to the surface in baskets on men's shoulders. The most important work was that of sinking a shaft at Nanoura, a spot to the south-east of the Oura mine. This was commenced in July, 1879, and completed in June, 1882, coal having been struck at a depth of 240 ft. There was great influx of water in completing this shaft, and hence much delay, but the difficulties of pumping it out were overcome, and this Nanoura mine became, and is, the most productive. The Oura, Miyanoura, and Nanoura mines were in full work in 1888, and the output had been increased to 1,200 tons a day, when the Government came to the conclusion that the Miike mine should be sold to some private purchaser if the reserve price of 4,000,000 dollars could be obtained, and on January 1st, 1889, the entire property was transferred to Mitsui for the sum of 4,550,000 dollars, and the sole control and working came into the hands of the Mitsui Bussan Kaisha.

As regards quality, I have already shown, in conjunction with Chorley and Baly, that Miike coal is quite equal to the best Lancashire coal (see *Journal of the Society of Chemical Industry*, 1891, pp. 975-980). Now as regards labour, this, too, being a period when we in this country are suffering for lack of it—the bulk of the mining labour is carried on by convicts. Years ago the demand for this labour had so much increased that the Government built a large convict prison in the neighbourhood of the Nanoura mine in 1882, capable of accommodating 1,600 prisoners, and when the Miike mine was sold to Mitsui it was stipulated by the Government that convict labour should be employed as hitherto, the Government receiving a fixed price for the work done. All the convicts immured in this prison are undergoing long sentences, none being in for less than twelve years, and nearly 400 for life. On first entrance the convicts are kept at labour in solitary confinement, or are put to work of a more or less rough nature until their character is determined in some measure. The refractory obtain no indulgencies, but are kept to solitary confinement and exercise, and when necessary there is the dark cell for punishment. All are dressed in cinnamon-coloured cotton garments, and those well conducted earn diamond-shaped blue badges, which are worn upon the left arm. When a prisoner has attained five of these good-conduct marks he is entitled to a ticket-of-leave, or a special pardon, and the good-mark men are allowed the privilege of better food once, twice, thrice, or four times a week, according to the number of good-conduct badges they have won.

Those not physically capable of working in the mine, and who have conducted themselves well, are permitted to work at various industries, such as mat-making, basket-making, weaving, shoemaking, etc., and a certain task for the day is allotted to each man. If this is accomplished, the Government takes seven-tenths of the value of such work, and sets aside three-tenths for the worker, and for all that is done over and above the allotted task the scale is reversed—the Government taking three-tenths, and according seven-tenths to the worker. The same system is observed with mining labour, and as more extra money can be made by this work, all are eager to be sent to the mine, especially as when underground they necessarily enjoy a certain degree of liberty. All the prisoners' clothing is made on the premises, and there is a large demand from Kobe for the matting made by the convicts. The utmost order and

cleanliness rule in the prison, and the food supplied is ample and good. There seems to be very little serious illness among the prisoners, and most cases under the doctors' care are from slight colds or injury to the eyes. Those in hospital are well cared for, and are allowed to while away the time by reading. An ingenious contrivance is used in all the buildings in which the prison cells are situated. A turn of an iron wheel simultaneously opens a door in each cell, so that in case of fire the prisoners can at once escape.

Roughly speaking, the Miike coalfield extends over 18 square miles, as defined in 1893, and the area of deposit was estimated to extend over some 3,758 acres, containing near 85,444,000 tons of coal. Several seams of coal occur in the Miike coalfield, but the first and second only are capable of being economically worked. The first seam averages 8 feet in thickness of pure, solid coal, without any interstratified bands of shale, as frequently found in most of the Japanese coal-seams. So far, the mines here are extraordinarily free from explosive gases, so that naked lights are invariably used and with impunity. The second seam lies only from 6 to 10 ft. below the first, and its thickness averages 6 ft. near the outcrops, though more irregular and uncertain in the deeper portions. The coal here is free-burning and non-caking, but its quality is inferior to the coal from the 8-ft. seam, and it is now worked only on a limited scale for local consumption.

One great disadvantage peculiar to the Miike coalfield, is the entire absence of shale in the strata overlying the coal. The strata, being composed of different kinds of sandstone more or less coarse, porous, or fissured, allow an easy passage to water from the surface to the coal-seam, thus rendering the process of mining expensive, and dangerous from flooding. On the other hand, the dip is comparatively gentle (about 5°), the roof is firm and strong, and no faults worth consideration are found. One of the strata contains fossil shells in great abundance. The output from 1877 to 1892 was—

1877	54,589 tons	1885	248,137 tons
1878	78,207 „	1886	277,718 „
1879	120,186 „	1887	317,717 „
1880	118,211 „	1888	368,109 „
1881	168,899 „	1889	462,271 „
1882	156,430 „	1890	487,641 „
1883	158,592 „	1891	574,330 „
1884	209,775 „	1892	468,831 „

From 1904 to 1913 the annual production and exports were—

Year.	Output (tons).	Amount exported (tons).	Percentages of export.
1904	1,236,639	668,637	54·07
1905	1,301,126	678,785	52·17
1906	1,455,469	493,297	33·89
1907	1,469,429	640,174	43·57
1908	1,525,480	601,526	39·43
1909	1,539,030	609,326	39·59
1910	1,785,206	733,342	41·08
1911	2,036,024	834,594	40·99
1912	2,039,807	1,051,675	51·56
1913	2,156,954	959,510	44·50

Coal, Coke, and By-products from Coking.—The coal has a brownish lustre, and is highly bituminous. Owing to its great steaming power, high heating value, and uniform quality, it has acquired the reputation of being the standard coal on the Asiatic markets. The average evaporating power of the lump coal is 9·72 lb., water evaporated at 212° F. by 1 lb. The fine coal is peculiarly fitted for forging purposes, and commands a wide market both at home and in Chinese ports. The gas-producing power of Miike coal has long been recognised by the gasworks of Japan and China. It cakes easily, and coke of excellent quality is made in Kopper's regenerative coke-ovens, with a by-product plant installed at the colliery. The average results are—

Per Ton of Miike Coal.

Coke produced	1,500 lb.
Gas produced	11,000 cub. ft.
Coal tar produced	166 lb.
Ammonium sulphate produced	21·3 lb.

There are at the Miike colliery 92 Kopper's regenerative coke-ovens with a by-product recovery plant producing over 100,000 tons of coke, and 1,420 tons of ammonium sulphate per annum, besides coal-tar products by distillation of the tar.

Mine-workers, etc.—The mine-workers number 14,240 in all, including underground and surface hands. They are comfortably housed, and rice and other necessaries of life are supplied at the canteens at cost prices, and special reduction is made, even from these, for long-service miners. All the miners are required to save from 5 to 10 per cent. of their earnings, so as to provide against contingencies. Liberal rewards are given for regular attendance. The colliery even provides three nurseries for the care of infants during the mothers' absence at work.

Education.—The education of mine-workers' children is receiving close attention. There are five elementary schools at the mines with an aggregate attendance of over 1,000 children. Besides these, day and evening classes are opened for boys in the service of the colliery offices and works, giving them opportunities to pursue higher studies and so qualify themselves for posts of responsibility. With the object of turning out competent foremen and assistants in the fields of mining and engineering, a special institution, with the name of the Mitsui Technical School, was established in 1907 near Omuta, under the patronage of the Mitsui families, for the benefit of the public. There are three departments, viz. mining, mechanical, and electrical engineering. One of the special characteristics of the school is that the whole of the colliery works are thrown open to the students, and there, in addition to the regular curriculum, practical training is given them under the guidance of engineers and foremen.

Hospital Accommodation.—The Miike colliery maintains a well-equipped hospital in Omuta intended exclusively for the colliery employees and their families. At present, the hospital has a

staff of 19 physicians, 36 nurses, and a number of attendants. The hospital can accommodate 80 patients. It has a branch at each mine, and also at the Miike harbour.

Foreign Markets.—The chief foreign markets for the Miike coal are Shanghai, Hong-Kong, Singapore, Manila, and Java.

Other large collieries are those of Tagawa, output 980,114 tons in 1913; Yamano, output 407,952 tons in 1913; Hondo, output 380,884 tons in 1913; Noborikawa, output 100,678 tons in 1913. In all these, as in the Miike mine, the welfare of the workers and their children is zealously seen to.

GOLD AND SILVER MINES.

The Kushikino Mine.

This mine is situated in the province of Satsuma, the southern extremity of Kyushu. It is said to have been first opened a few centuries ago. The Mitsuis purchased some part of it in 1906, and the remainder in 1911. The present metallurgical works were completed in 1913. The concession comprised a surface of 1,823,294 tsubo (1,489 acres). The ores are mined by means of the pneumatic drill as well as by hand. Explosives are also applied as required. Drainage is effected by means of electrically-driven turbine pumps. Formerly the gold and silver were extracted in the main by amalgamation, yielding only 60 per cent. of the gold and 25 per cent. of the silver contained in the ore, but since the Mitsuis took over the mine the all-sliming cyanide process was adopted, and extensive plant was completed in 1913. The extraction rate for gold attained 90 per cent., and for silver 80 per cent. of that contained in the ore.

Motive Power.—To obtain electric power for various purposes, an electric central power-station is established, consisting of four sets of vertical gas-engines, each developing 318 B.H.P. driven by producer gas.

Mine-workers and their Treatment.—The mine-workers, including underground and surface hands, number about 660. The mine is provided with a hospital with staff of medical men.

Kamioka-Kushikino-Kongo.

The Kamioka Zinc, Lead and Silver Mine.

This mine is situated in Central Japan, and is said to have been first opened some twelve centuries ago, and different portions of the mine were worked on a small scale by independent proprietors until the Mitsuis amalgamated the mines in 1888, when a modern and extensive system of development was begun. The area of concession covered 8,638,495 tsubo (7,057 acres). The ores are chiefly silver-bearing galena and zinc blende. They occur in irregular deposits, the largest ranging from 50 ft. to 60 ft. by 300 ft. or so, and the depth known by actual mining is over 1,000 ft. The metals produced at Kamioka are zinc, lead, and silver, besides some copper, gold, bismuth, and arsenious oxide. The output of ores and metals in each of the ten years ending in 1913 is as follows:—

Year.	Gold.	Silver.	Copper.	Lead.	Zinc concentrates.	Bismuth.	Zinc dust.	Zinc.	Arsenious oxide.	Argentiferous copper.	Refined lead.
	oz.	oz.	tons.	tons.	tons.	oz.	tons.	tons.	lb.	tons.	tons.
1904 .	—	151,322	70	1,278	—	—	—	—	—	—	—
1905 .	—	134,399	82	1,519	—	—	—	—	—	—	—
1906 .	—	146,027	74	1,926	1,738	—	—	—	—	—	—
1907 .	—	176,758	36	2,090	5,689	—	—	—	—	—	—
1908 .	272	186,778	39	2,130	8,679	—	—	—	—	—	—
1909 .	231	187,276	32	2,470	10,400	951	—	—	—	—	—
1910 .	420	197,549	27	2,579	11,021	—	—	—	—	—	—
1911 .	653	209,341	8	3,004	15,155	—	—	—	—	24	—
1912 .	890	239,595	—	2,823	19,371	—	—	—	—	31	84
1913 .	1,417	266,412	—	2,797	21,410	11,132	5	350	39,676	28	—

Mining.—The prospecting of the body of ore is carried on by driving levels at different altitudes. In case of massive deposits, the ore occurs mostly at the intersection of veins. The mining is mostly effected by overhand stoping and in rare cases by underhand stoping. Explosives are applied wherever required. Drainage is effected principally by levels driven in from the surface, as the workings lie high up the mountain, and wherever mechanical drainage is required water-jet pumps are used. The higher parts of the mine above water-level are naturally ventilated, and the lower parts are ventilated by mechanical fans.

Concentration and Smelting.—All kinds of ore here contain considerable amounts of zinc. Two concentration plants have been established. Part of the zinc concentrate is sent to Miike, where ten recuperative furnaces, each capable of treating five tons of ore per day, are installed, and spelter of 99·9 per cent. of pure zinc is obtained. The lead concentrates are roasted in reverberatory furnaces

and pots, and then smelted in a blast-furnace with suitable fluxes, thus producing rich lead, matte, and slag. After liquation and softening, the lead is desilvered by zinc. The zinc scum is distilled, the resulting zinc being used again for desilvering, whilst rich lead is cupelled. The desilvered lead is refined, cast in ingots, and sent to market. The matte is repeatedly roasted and smelted for lead, and the concentrated matte is subjected to oxidising smelting for copper. As lead contains about 0·2 per cent. of bismuth, the Pattinson Rozan desilvering plant is installed.

Motive Power.—Water power is used, and the motors are mostly of the Pelton type. The horse-power developed amounts to 688 h.p. Besides this, 220 h.p. of electric power are consumed for various purposes in zinc refining at Miike.

Mine-workers and their Treatment.—The mine-workers, including underground and surface hands in the Kamioka mine, and the employees in the zinc refinery at Miike, number over 3,000. There are three elementary schools, and a hospital at the mine. All the mine-workers are supplied with necessaries of life at a canteen established for their exclusive use.

Kongo Tungsten Mine.

This mine is situated in the Kongo mountain range in Korea, famous for its scenic grandeur. The extent of the concession is 564,600 tsubo (461 acres). The mine appears to have been first opened by a Japanese in 1912, and the Mitsui Mining Company purchased it in 1914. The output of tungsten ores in the last two years is as follows—

Year.	Tungsten ore.	WO_3 content.
1912	11·8 tons	65 per cent.
1913	16·9 ,,	68 ,,

The ore is wolframite, occurring in quartz veins found in granite; also a small amount of cassiterite and molybdenite; gold and silver is found in quartz veins. To concentrate, the ores are crushed and sorted by manual labour. The concentrate contains from 60 to 68 per cent. of WO_3. It is expected, however, that this strength will be improved up to 72 per cent., when the concentration plant now in preparation is completed. As regards the mining, this is effected by the open cuts, and explosives are applied as required. The total length of excavation attains 4,000 ft. and the average depth is 15 ft. Underground mining by overhand stoping will in the future be adopted. The number of miners is about sixty.

Sulphur Mines.

Iwaonobori Sulphur Mine.—This mine is in the province of Shiribeshi, Hokkaido. It has been worked by the Mitsui firm since 1886, and the area of concession covers 560,724 tsubo (458 acres). The output of ore and refined sulphur during the last ten years is as follows—

Year.	Ore produced.	Sulphur refined.
1904	11,297 tons	2,250 tons.
1905	10,532 ,,	2,184 ,,
1906	10,463 ,,	2,039 ,,
1907	17,465 tons	1,590 tons.
1908	17,038 ,,	3,026 ,,
1909	22,387 ,,	3,041 ,,
1910	32,527 ,,	4,865 ,,
1911	43,607 ,,	7,671 ,,
1912	37,104 ,,	8,363 ,,
1913	44,341 ,,	9,072 ,,

The sulphur ore is found mostly in beds mixed with clay and partly as impregnation in volcanic rocks. It is mined almost exclusively in open workings, and the main portion of the mined ore is refined by steam liquation, and a small portion by sublimation. The refined sulphur contains over 99·5 per cent. of pure sulphur, and is largely exported to San Francisco, Australia, China, etc. The crude ore generally contains 60 to 70 per cent. of sulphur, and is partly sold direct to sulphuric acid and fertiliser manufacturers in various parts of Japan.

Owing to the deep snow of winter, mining is suspended for about six months, usually from the middle of November.

Kobui Sulphur Mine.—Situated in the province of Oshima in Hokkaido, the deposit was discovered fifty-one years ago, and was purchased by the Mitsui firm in 1911, the area of concession being 1,352,772 tsubo (1,105 acres). The production during 1912 and 1913 has been—

Year.	Sulphur refined. Tons.
1912	11,195
1913	10,046

The sulphur ore is found in deposits amongst volcanic rocks. The method of mining is given as the "long-wall working." Ventilation is by natural draught, and drainage by natural flow. The mined ore is refined by simple sublimation, and the refined product contains 99 per cent. of pure sulphur. It is largely exported to Australia, New Zealand and the Pacific coast of America. The raw mineral and the refined sulphur are chiefly conveyed by horse tramway from mine to shore. The mine-workers, underground and surface hands, number about 680.

The Itava Sulphur Mine is in the northern part of the main island of Japan. It has been worked by the Mitsui firm since 1914. The area of concession is 526,157 tsubo (430 acres), and the output of mineral and refined sulphur in 1913, was—

Mineral (ore) produced	4,769 tons.
Sulphur refined	390 ,,

The mineral is found as sulphur impregnating volcanic tuff, and the method of mining is described as the "pillar-and-stall" and "long-wall" systems. Explosives are used as required. The mined ore is refined in the modified "Gill's furnaces," or by sublimation. The refined sulphur contains on an average 99·62 per cent. of pure sulphur and is largely exported to the United States and Australia. The mine-workers, underground and surface, number about 130.

ENGINEERING NOTES.

The Rocky Mountain Division of the Chicago, Milwaukee and St. Paul Railway.—With reference to the electrical tests of the above railway given in one of the Engineering Notes of March 9th, this line has now undergone a six months' trial, and certain advantages appear to have been demonstrated. One of these is a material reduction in running time. On one 21-mile 1 in 50 gradient alone the time for passenger trains has been reduced from 1 hour 5 minutes to approximately 40 minutes. In the goods service it has been found that where steam locomotives have required from ten to twelve hours to make 115 miles, electric locomotives can meet a schedule time of from seven to eight hours for the same distance. The capacity of the new locomotives has been thoroughly tested. Trains of 3,000 tons have been hauled east and 2,800 tons west, an assistant engine being used on the heavy grades. On some of the runs, where the grades are less than 1 in 100, trains of as many as 130 trucks and as heavy as 4,000 tons have been hauled by a single locomotive. It has been shown that much heavier trains can be hauled with the electric locomotives than by steam, and furthermore the capabilities of the electric equipment are not impaired by bad weather. During a series of record-breaking temperatures last December, Mallet engines were frozen up at several points and were rescued, with their trains, by electric locomotives. Through passenger trains of 650 tons are hauled 220 miles by a single electric locomotive. Steam operation required a change of engines midway. Local passenger trains are handled by a half unit. The regenerative braking has proved an easy solution to a difficult problem on the long mountain grades. Electric goods trains usually descend the maximum grades at 17 miles per hour, but half that speed can be maintained if desired. In case there are no other trains between the substations to absorb the power generated by a descending train, the power passes through the substation machinery, and is readily absorbed by the extensive system of the power company. There are forty-four electric locomotives on the division, twelve passenger, thirty goods and two switching. They operate on the 3,000-volt direct-current system, being the first to use so high a direct-current potential. For a distance of 440 miles this railway has been electrified, the first unit of 115 miles being already in actual operation. The full East to West sweep of the Rocky Mountains is traversed, and the electrical line runs across the three principal mountain ranges. This is believed to be the longest section of electric railway service in existence. The immense electrical energy required is obtained by water power from mountain waterfalls, and the power is transmitted over long distances with the greatest efficiency. It may be mentioned that the full mileage of the Chicago, Milwaukee, and St. Paul Railway is to-day more than 10,000, and on its lines are situated nearly 1,000 cities and towns of commercial significance. The entire work of electrification cost approximately £2,500,000, and has required three years to complete. Some of the above particulars are extracted from the *Engineering Record* of New York.

Progress of New Southwark Bridge.—This bridge, which will have five spans instead of the three of the old bridge, is being erected on four piers and has been designed to give a head-room of 26 ft. above Trinity high water. According to the *Times*, the centre span is 140 ft. 6 in., the intermediate spans 131 ft. 9 in., and the two shore spans 123 ft. The arches will be composed of seven steel ribs placed as regards the two outside ones at 5 ft. centres, and as regards the others at 8 ft. 9 in. centres. Beyond the outer ribs cantilever arms will project for a distance of 6 ft. 5 in., and on these a portion of the footpath will be carried. The roadway will be 35 ft. wide and the footways 10 ft. wide, giving a total width of 55 ft., as compared with 42 ft. 6 in. of the old bridge. The present position of the work, which is being carried out by Sir William Arrol & Co., is that the pier on the City side of the river has been completed up to road level, while that on the south side is rapidly approaching a similar state. The sinking of the permanent caisson for the foundation of the second pier from the City side has reached a point within a few feet of foundation level, which is 50 ft. below high water, while in the case of the fourth permanent caisson the building of the steel work is in an advanced state. The caissons are remarkable for their size, measuring 102 ft. by 30 ft., whereas those of the Forth Bridge, which are circular, are of 70 ft. diameter. They are sunk into the river in the ordinary way by means of compressed air, the pressure employed being 22 lb. per square inch, but one or two special features are presented by the method employed by the contractors. At the beginning the caissons are placed between temporary guide-posts and lowered until they float in the water. At this stage, the caisson body being filled with concrete and the building of the masonry for the piers started, the pier is thrust downwards by the pressure of the superimposed weight regulated by the air pressure and the excavation carried out within the working chamber. At a point halfway between high and low water the masonry work is stopped for the time being, and the work of putting the foundation steelwork in position is continued under the compressed air method of excavation. On the foundation caissons reaching the predetermined foundation level, the interior working chamber is filled up solid with mass concrete, the air pressure released, and the building of the upper courses of masonry proceeded with.

Fire Prevention at Sea.—The need for perfect fire-fighting plant on land is urgent enough; how much more so, then, at sea. With the object of bringing the subject prominently before the notice of those concerned, the British Fire Prevention Committee have just issued, as Red Book No. 203, some important suggestions on fire protection for passenger ships of 1,000 tons gross register and over. These may be classified under the headings: (*a*) Ship fires and fire records; (*b*) preventable causes of fire on board ship; (*c*) discovery of fires on board ship; (*d*) first-aid fire appliances on board ship; (*c*) main fire appliances on board ship; and (*f*) ship's fire service. Other sections in the Red Book, copies of which are obtainable at the committee's offices, give extracts from the International Convention as to safety of life at sea, the Board of Trade's War Emergency Notice of 1915, and the Merchant Shipping Advisory Committee's recommendations on the subject of fire protection. The main fire appliances on board ship should be based on a good hydrant service on both sides and on all decks—a primary essential that should be compulsory. It is recommended that hydrants should always be kept under moderate pressure from steam-pumps installed in or near the main engine-room, and in the same watertight compartment as the main steam generating plant; and that there should be on no passenger ship of more than 1,000 tons register less than two such steam-pumps, such pumps being interchangeable and serviceable for the entire hydrant system, so that water under pressure may be obtainable at all times, even if one of the pumps breaks down or is out of working order. Supplementary to the hydrant system, the committee urges that it should be compulsory that a ship should have a certain number of independent steam fire-engines—*i.e.* fire-engines entirely independent of the steam supply of the ship, and should also have a certain number of manual fire-engines. Certainly if ships were generally equipped with fire-fighting plant on these lines there would be far less chance of hearing of that most terrible of all maritime disasters—a ship on fire at sea.

Combination Steam and Gas Engine. — The following abridged account of this engine is from the *Engineer.* Power-generating equipment of a very novel and remarkable character has been adopted for the large automobile works of the Ford Motor Company at Detroit. It comprises electric generators driven by a combination of gas and steam engines, with boilers and gas producers, and regenerators to utilise the waste heat. There will be six main units, each with a capacity of 6,000 horse-power, at a speed of eighty revolutions per minute. The arrangement resembles that of a horizontal twin tandem compound steam-engine unit, but one side consists of a two-cylinder tandem gas-engine, and the other side consists of a two-cylinder tandem compound steam-engine. The engines are connected to opposite ends of a shaft, upon which is mounted a generator of 4,000 kilowatts for 250-volt continuous current. The gas-engines have water-cooled cylinders 42 in. by 72 in., and are of the four-cycle double-acting type. The gas exhaust is utilised in a steam superheater on the steam main between the high-pressure and low-pressure cylinders of the steam-engine. A portion of the exhaust gas is passed through the jacket of the high-pressure cylinder in order to reduce heat loss. Finally, the exhaust gases are utilised in the feed-water heaters for the boilers. This water has already passed through the cylinder jacket of the gas-engine, and has thus been heated to about 160° F. or 180° F. before it enters the heater, in which the exhaust gas raises the temperature to about 250° F. for the feed. The gas-steam unit is designed to combine the economy of a gas-engine under constant load with the reliability of a steam-engine under varying load. A gas-engine operates to best advantage, as a rule, under full load and constant load, but under such conditions there is practically no overload capacity. The general practice, therefore, is to run the engine rather underloaded. This produces wire-drawing of the gas through the valves and ports, which tends to cause a precipitation of tarry matter. Such trouble does not occur with the engine running under full load. With the combination gas-steam unit the gas-engine does not come into service until there is at least something more than half load on the unit, so this engine will be normally under full load. The steam-engine does all the governing and can meet fluctuations in the load. The only governing on the gas-engine is to prevent excessive speed. In case of trouble with the gas side of the unit, the steam side can handle the full load by giving a late cut-off. The electric generator weighs 105 tons and has an armature 16 ft. diameter, weighing 45 tons. The field frame is 21 ft. high and 26 ft. wide across the projecting feet which support it upon its foundations. Considerable trouble has been experienced in completing and adjusting the units so that they will operate in service in the manner designed. There has been trouble also with the gas-producer plant. Taken altogether there appears to be some scepticism among American engineers as to the economical and efficient operation of the combination units, and especially as to the reliability and freedom from operating troubles which is such a desideratum for the power equipment of manufacturing establishments. The first units were installed by the end of 1915; it is hoped to have the entire installation completed shortly, and it will be interesting to hear how the engines work.

Simmer Pan Electric Power Station, Transvaal.—The Victoria Falls and Transvaal Power Company issue the following particulars with respect to the above scheme. The generating plant at Simmer Pan comprises six 4,000 k.v.a. turbo-alternators, and two additional turbines in course of erection. Both of these, together with the new boiler plant, were put in operation early last year. Each of these generators is of 11,000 kw. (15,700 k.v.a.) capacity, the alternators being of the totally-enclosed type. There are three single-phase transformers operating in conjunction with each of the above alternators (one in each phase), and stepping up from 5,000 volts to either 42,000 or 10,500 volts. These transformers were made by the American General Electric Company in Schenectady, and are of the oil-insulated water-cooled type, contained in circular cases, with the high-tension leads entering the top. The existing boiler-house at Simmer Pan was enlarged, and eight Babcock and Wilcox standard marine-type boilers, with chain-grate stokers of their latest design were added. Each of these boilers is of 33,000 lb. to 38,000 lb. per hour rated capacity, with internal superheater. Regarding extensions at the company's other stations, it may be mentioned that last summer the work of installing at the Brakpan station of two further three-phase turbo-alternators, each of 12,000 kw. capacity, and ten boilers similar to those already put into commission at Simmer Pan, was completed, and the plant was brought into use. At Rosherville eight boilers of 33,000 lb. capacity were installed, and three further turbo air compressors, each of about 10,000 h.p. capacity. Under normal conditions, the four stations (*i.e.* Vereeniging, Brakpan, Simmer Pan, and Rosherville) are operated in parallel, and the average load during the heaviest hour of an average day reaches 100,000 kw. This should not be confounded with the peak loads, which may be considerably higher. The total generating capacity of the four power stations is now more than 137,000 kw. The present business (inclusive of the supply of compressed air) closely approaches 600,000,000 units sold per annum, and the extensions of plant will enable this figure to be considerably increased in the near future.

GENERAL NOTES.

Science and Modern Languages.—In pursuance of the arrangements which the Government have made for reviewing the system of education as a whole, the Prime Minister has appointed two committees to inquire into the position of science and modern languages respectively in the system of education in Great Britain. (1) The terms of reference and constitution of the Science Committee are as follows: To inquire into the position occupied by Natural Science in the educational system of Great Britain, especially in secondary schools and universities; and to advise what measures are needed to promote its study, regard being had to the requirements of a liberal education, to the advancement of pure science, and to the interests of the trades, industries, and professions which particularly depend upon Applied Science. Sir J. J. Thomson, O.M., D.Sc. (Chairman); the Right Hon. F. D. Acland, M.P.; Professor H. B. Baker, D.Sc., F.R.S.; Mr. Graham Balfour; Sir William Beardmore, Bt.; Sir G. H. Claughton, Bt.; Mr. C. W. Crook; Miss E. R. Gwatkin; Sir Henry Hibbert, M.P.; Mr. William Neagle; Mr. F. G. Ogilvie, C.B.; Dr. Michael Sadler, C.B.; Professor E. H. Starling, M.D., F.R.S.; Mr. W. W. Vaughan; secretary, Mr. F. B. Stead, H.M. Inspector of Schools. (2) The terms of reference and constitution of the Modern Languages Committee are as follows: To inquire into the position occupied by the study of modern languages in the educational system of Great Britain, especially in secondary schools and universities, and to advise what measures are required to promote their study, regard being had to the requirements of a liberal education, including an appreciation of the history, literature, and civilisation of other countries, and to the interests of commerce and public service. Mr. Stanley Leathes, C.B. (Chairman); Mr. C. A. Montague Barlow, M.P.; Mr. E. Bullough; the Right Hon. Sir Maurice de Bunsen, P.C., G.C.M.G., G.C.V.O.; Mr. A. G. Coffin; Dr. H. A. L. Fisher; Mr. H. C. Gooch; Mr. J. W. Headlam; Mr. L. D. Holt; Dr. Walter Leaf; Dr. G. Macdonald, F.B.A.; Mr. A. Mansbridge; Mr. Nowell Smith; Miss M. J. Tuke; Sir James Yoxall, M.P.; secretary, Mr. A. E. Twentyman.

Iron and Steel Institute.—The autumn meeting of the Institute will be held at the Institution of Civil Engineers, Great George Street, Westminster, on Thursday and Friday, September 21st and 22nd, 1916. The following is the list of papers that are expected to be submitted for reading and discussion:—(1) H. Brearley, "Some Properties of Ingots"; (2) Professor E. D. Campbell, "Influence of Heat-Treatment on the Thermo-Electric Properties and Specific Resistance of Carbon Steels"; (3) Dr. H. M. Howe and A. G. Levy, "Heat Treatment of Eutectoid Carbon Steels"; (4) J. N. Kilby, "Steel Ingot Defects"; (5) Herbert K. Scott, "Manganese Ores of the Bukowina, Austria"; (6) Dr. J. E. Stead, F.R.S., "Influence of Elements on the Properties of Steel"; (7) Dr. J. E. Stead, F.R.S., "Notes on (*a*) Nickel Steel Scale, (*b*) On the Reduction of Solid Nickel and Copper Oxides by Solid Iron, (*c*) On Effect of Blast Furnace Gases on Wrought Iron"; (8) G. F. Zimmer, "Use of Meteoric Iron by Primitive Man."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

CANTOR LECTURES.

The Cantor Lectures on "Optical Glass," by Dr. Walter Rosenhain, F.R.S., Superintendent of the Metallurgy Department, National Physical Laboratory, have been reprinted from the *Journal*, and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

A full list of the Cantor and Howard Lectures which have been published separately, and are still on sale, can also be obtained on application.

PROCEEDINGS OF THE SOCIETY.

FOTHERGILL LECTURES.

HISTORIC BUILDINGS IN THE WESTERN WAR ZONE: THEIR BEAUTY AND THEIR RUIN.

By the Rev. G. Herbert West, D.D., A.R.I.B.A.,

Author of "Gothic Architecture in England and France."

Lecture III.—Delivered February 21st, 1916.

FRENCH MEDIÆVAL SCULPTURE.

The history of mediæval Christian sculpture is complicated in its earlier stages by its being the expression of a vigorous new society coming to life amidst, or upon, the dying embers of the civilisation of an effete race. This is curiously illustrated even so late as the eleventh century in the sculptural art of Southern France, where, as at Vezelay and Autun, over the stiff foliage of fairly correctly carved Corinthian capitals may be seen wandering strange, uncouth, northern figures which tell some Scripture story such as the expulsion from Eden or the sacrifice of Isaac. Yet pure classical traditions lingered on, especially in Provence, the only part of the empire where any of the old life was left. Although, as everywhere, there is a great gap between the eighth century and the eleventh, yet it is impossible not to see these traditions reappearing in such remarkable compositions as the great porches of St. Trophime at Arles and St. Gilles (about 1200). In the cloister at Arles there are clear traces of Byzantine influence, but it is not that which preponderates in the porch. Fine as the compositions are as a whole, with good proportions and beautiful detail, yet there is no promise in them, they are lacking in life, in expression—the work is that of an art which is dying, not of one which is being born. This is clearly seen if it is compared with such a contemporary work as the tympanum of the Cathedral of Cahors. Grotesque as that may appear to us now, it is full of the power and life and promise which the other lacks. Like the rather later north door in the front of Chartres, it represents the Ascension. The figure of Christ is dignified and full of expression. The folds of the drapery are free and ample, with very little trace of Byzantine stiffness. There is a roundness and modelling about the figures superior to the flat, fret-sawlike work of the great door at Vezelay, which is of about the same date (1104).

Several schools of sculpture arose in France during the eleventh and twelfth centuries. That which was the first to free itself from classical limitations was the Burgundian. Its chief characteristic is breadth and firmness. It avoids the dryness of Byzantine work and shows a wonderful imaginative power. The Burgundians were already Christians and good workmen when they crossed the Jura, and from their great Abbey of Cluny, founded in the tenth century, issued an extraordinary artistic influence. The abbey itself was destroyed in the Revolution, but we may form some idea of it from Vezelay, the main door of which is one of the most remarkable works left us. It dates from the end of the eleventh century. The upper part of the tympanum represents the Day of Pentecost.

The drapery of the Christ and that of the Apostles is tossed about by the rushing mighty wind, and beams of fire from His hands touch the brows of each. The eight square compartments round represent possibly the seven Churches, the bottom one on the left being the Apostle writing under the dictation of the Saviour. There is a life and expression in these figures vastly in advance of the monotony of those of Arles; for example, in the two figures of St. Peter and another Apostle on the right-hand pillar there can be no doubt that St. Peter is gravely rebuking the other, who is listening attentively. The subject of the lintel is unknown. It is perhaps the "Apport," the people of all the earth, as in Acts ii., bringing contributions to the abbey, or it may be an allegorical representation of the Last Judgment, the saved being represented by the Israelites entering Canaan, the lost by the representation of the different vices, Pride being the little man getting on horseback by a ladder; Falsehood and Slander the people with ears reaching down to their feet.

The classical influence is still very strong, especially in the ornamental details, and in the two outer orders of the arch. But it is almost more visible in a somewhat later (*c.* 1140) but inferior work, the Last Judgment tympanum at Autun, of which we shall speak later. Yet, in spite of this inheritance of the past, one cannot but recognise the promise of the future in the strong dramatic feeling of the whole. At Autun Roman remains were very numerous, and the design of the cathedral is copied from the Roman Porte d'Arroux. The classical influence is most marked in the central pier, where one can see, not only Byzantine, but pure Greek influence. Let me, before passing on, give one or two more examples of how a classical spirit is occasionally to be found almost to the end of the Gothic period. The beautiful twelfth-century figure of St. Stephen, so dear to the people of Sens that they preserved it even through the Revolution, shows it strongly, and the ornament on the sides of the piers is pure Roman.

But the most remarkable instance is the late thirteenth and early fourteenth century work at Auxerre. It is quite noticeable in the treatment of the nude figure of Bathsheba, and in all the draperies, but especially in the exquisite figures of the Seven Arts, which are worthy of being placed with the Tanagra statuettes, and also in a sleeping Cupid and many of the smaller figures.

We will now rapidly pass on through the semi-classical Burgundian Romanesque of the twelfth century to the fully-developed thirteenth-century work of the Île de France and Champagne.

North of Burgundy, round Bourges, a school of sculpture arose in the twelfth century, in which we find a mixture of many influences, Gallo-Roman, Byzantine, and above all northern Romanesque. This last is specially marked by the elaborate ornamental detail. It is curious how these northern races begin by covering every inch of their buildings with mechanical ornament, much as the South Sea islander covers his paddle. Only gradually do they learn the value of the plain surface and of the concentration of ornament on certain points. On the old side doorways of Bourges, as in the rather earlier work of Avallon, we find the germ of the glorious porches of the Île de France with statues placed among the columns. But as they are rightly felt to be part of the architecture, they are made longer than nature. It was not ignorance but true artistic feeling which dictated their proportions. This is still more noticeable in the wonderful west portal of Chartres, dated from 1140, which was moved forward when the cathedral was lengthened in the thirteenth century. The statues are strongly individual portraits of living persons, not, as was the case later, brought into conformity with an ideal type. The dignified kings and queens with the mysterious smile are those mentioned in St. Matthew's genealogy; but unfortunately statues of kings on the cathedrals were taken in the Revolution to be kings of France, and ruthlessly destroyed, so that much of the early history of French sculpture is lost.

The capitals of the columns are still covered with stories from the Old and New Testament, and their true carrying function is not clearly marked, nor had the complete scheme of sculpture yet been fixed. Thus we still find Christ in the tympanum surrounded by the emblems of the four evangelists, as at Bourges, instead of the Christ in Judgment, which becomes the rule later. The left-hand door represents the Ascension and is worth comparing with the earlier work at Cahors, by which it was perhaps inspired. The right-hand door is the Virgin's door, as became usual in the fully-developed scheme of iconography, of which the first idea is to be found at Laon, and which, during the thirteenth century, furnished a more or less fixed programme to all the great cathedrals. Starting with the three great portals, the central door gives us Christ on the pier as the Judge of the

world, with the Last Judgment on the tympanum above Him, and with His assessors, the Twelve Apostles standing on either side of Him, each with his emblem beneath his feet, or, in the earlier examples, seated on the lintel below Him; while on the jambs of the door itself are the wise virgins who entered with the Bridegroom, while "the door was shut" against the foolish ones "who stood without, crying, 'Lord Lord, open to us.'" Could any scheme of decoration be more solemnly appropriate to the entrance of the House of God in the arches, patriarchs, saints and angels? The second door, that in the place of honour on the right, was consecrated to the life of the Blessed Virgin, and the third, or the side doors, to the histories of some local saints—St. Firmin at Amiens, St. Sixtus, St. Nicaise or St. Remy at Reims, St. Marcel at Paris. Other doors were consecrated to saints, some of whose relics were amongst the treasures of the Church, St. Anne at Chartres, St. Thomas at Semur, St. Stephen at Paris. Between the doors at Paris, on the great buttresses, were two large figures carrying the line of sculpture across from door to door, the synagogue on the left of our Lord with the eyes blindfolded and the Book shut, the Church with open eyes and open Book on the right, and above, in the great gallery, the statues of the kings of Judah, ancestors of the Blessed Virgin.

The thirteenth century was the age of encyclopædias. Thomas Aquinas summed up all theology, Jacobus de Voragine collected all the legends of the saints in the Golden Legend, Durandus epitomised all writers on the liturgy, and Vincent of Beauvais attempted to embrace universal knowledge. It was on his work, as M. Male* has shown us, that the whole artistic scheme of the great cathedrals was based, and it was the Cathedral of Laon which first gave the pages on which the story was to be written.

That story is arranged as in de Beauvais' "Speculum" in the four chapters or mirrors of Nature, of Instruction, of Morals, and of History—that is, of the history of the Church. We have then (1) the Signs of the Zodiac in the heavens, the work of Creation on earth, leading up to the creation of man; (2) *Instruction to Salvation*—the story of the Fall of Man and of his redemption, the Labours of the Months, the liberal Arts; (3) *In Morals*—the Virtues and Vices, the Active and the Contemplative life; (4) *The History of the Old Testament as leading up to the New*—prophets, patriarchs and the kings of Judah, the legendary story of the Blessed Virgin, the Saints and their legends, all leading up to Christ and the Final Judgment and finding its centre there.

The façade of Laon is too early, and that of Paris is so largely a modern restoration, that we had better go for our chief example to the great north and south porches of Chartres, which were finished in the last quarter of the thirteenth century, about forty years later than Notre Dame. That on the north, which is the richer and the more perfect in design, loses by never getting full sun, and must have lost even more at first when they both were painted and gilt. The south porch also gains greatly by being raised on a flight of steps. In no buildings, not even in the Parthenon, is there so perfect a union between architecture and sculpture as in these two porches. Let us begin with the south porch. It is less elaborate than the north, and the square piers adorned with bas-reliefs between the columns are much less effective in their light and shade than the narrow arches and statues of the other. The large statues are, however, even finer, the heads noble and full of character and suggestion of moral beauty, the draperies almost classic in their simple grandeur. Since there is no arcade for the kings of Judah on the west front, they are placed here, six on each side of the porch and three on either side of the central archway.

Since the twelfth-century sculptures of the west front were already given to the glorification of Christ, the central door here is the Judgment door. Christ is in the centre showing His wounds, the Virgin and St. John on either side, pleading for sinners, and six angels with the instruments of the Passion, the two lower ones with the lance, the pillar and scourge, the upper ones holding the nails, the crown of thorns and the Cross, which seems to have no arms. On the central pillar is Christ, a very beautiful figure, standing on the lion and the dragon. There are six Apostles on either side standing on their executioners, and in the five orders of the arch the nine choirs of angels.

As specimens of the statues, we may take those of the right-hand door, beginning on the left. (1) St. Leo Pope with a conical tiara; on the pedestal three heads. (2) St. Ambrose pushing the end of his crozier into the mouth of a figure on the pedestal—Maximus, who made himself Emperor in opposition to Valentinian. (3) St. Nicholas, Archbishop of Myra. The man on the pedestal (without a head) is the

* "French Thirteenth Century Sculpture," Male. Dent & Co.; and "The Sculptures of Chartres," Marriage. Camb. Univ. Press.

innkeeper who murdered and salted down three boys, according to the western legend, the real story being that St. Nicholas delivered three officers of the Emperor Constantine from prison. They are shown in the east as three little figures looking out of the top of the prison tower; in the west they were taken for three children in a tub, and the story invented accordingly.

On the right we have (1) St. Martin, the wonder-worker of the west, as St. Nicholas was of the east—a very fine statue. His soul shines in his face, active and severe. Beneath his feet are two dogs whom he stopped from pursuing a hare. (2) St. Jerome, with the Vulgate. Beneath on the pedestal a woman with her eyes bandaged (the Synagogue), with the roll of the Old Testament, which the saint is taking from her: she is trying to hold on her crown, which is falling off. (3) St. Gregory with the conical tiara. He used to dictate to his secretary from behind a curtain. One day his secretary drew back the curtain and saw a dove sitting on his shoulder and whispering to the saint. He is peeping out from the pedestal.

Between the columns on each of the square piers are panels giving the virtues and the corresponding vices, or lives of saints.

In the north porch the most beautiful of the larger statues are—on the central pillar, St. Anne carrying the infant Virgin, a beautiful figure of an old woman; Solomon, a type of Christ, a fine head with the technical skill of the later sculptors and the force of the earlier ones; and next him the Queen of Sheba, a type of the Church, as she came from the ends of the earth to hear the wisdom of Solomon, and is therein a type of the Magi—she is standing on a slave. Judith, a type of the Virgin as deliverer of her people, standing on a dog—the emblem of fidelity. Above, in the voussoirs of the arch, are scenes from the story of Judith, and next her the story of Gideon who was a type of Christ, because "Tau"—T the Greek for 300—is the sign of the Cross, and so his victory represented Christ's.

In the outside mouldings of the arch are the labours of the months and the signs of the Zodiac. April, a man holding ears of corn; October, a man knocking down acorns for pigs; January, a man with two heads, cutting bread and with a bowl of wine on the table. These, though better executed, are much less vigorous and full of life than the corresponding earlier series on the west front; compare, for instance, the He-Goat.

But the most beautiful figure in the north porch, perhaps in the whole cathedral, is that on the north-western angle of St. Modesta, the daughter of the Governor Quirinus. She was converted by the martyr St. Potentian, who stands next her; she was martyred, as is shown on the pedestal, by being thrown into a well. The figure is one of exquisite grace and modesty, and the face touchingly sweet and maidenly.

Time would fail us if we attempted to pass in review all the sculpture of the great French cathedrals; but before passing on to Reims, the crown of them all, we must just glance at Amiens, which offers us the model of the perfect union of sculpture and architecture. The wonderful porches of Chartres are additions to the church; the scale is not always perfect. At Paris nearly all the statues are modern and there is some lack of richness, and at Reims there is overmuch. At Amiens the two are perfectly combined, and the statues are almost all as fine as possible in life and individual expression, which is rather lacking at Chartres, and perhaps a little too marked at Reims, and also in scale of the great statues of the kings of Judah in the gallery and of the prophets at the entrance. The colossal statues of the kings are perfectly adapted to their position—the heads are bold, detail is sacrificed to the general effect to be got from below, the eyes prominent and looking down, the detachment of the nostrils from the cheeks exaggerated; they would not look beautiful in a museum, they are perfect in their place. The opposite would have to be said of much modern work, and even of some of that of the Greeks. The details of the figures in the pediment of the Parthenon, such as those of the Fates, would have been hardly visible from below, and parts of the seated and lying figures would have been hidden by the cornice.

As we have seen at Chartres and Paris, the figure of Christ is on the central pier, above Him the Judgment, and on either side the twelve Apostles. The great door of Amiens is the finest of all in the beauty of the figure of Christ, the nobility of the statues, and the spiritual beauty of their faces. Radiant with the light of the Holy Spirit, they gaze before them with profound serenity. At Chartres and at Reims some of the statues are poor works of art: at Amiens hardly one falls below the general level of excellence. On the right of Christ are: (1) St. Peter with the keys and Cross; (2) St. Andrew with a Latin Cross; (3) St. James the Great with a sword and the scallop shells of a pilgrim; (4) St. John holding the poisoned cup which Aristodemus gave him to drink; the

next is probably St. Philip; then comes St. Bartholomew, who should be holding the knife with which he was flayed alive (the axe is modern).

On the left of Christ come—(1) St. Paul with a sword; (2) St. James the Less with a club; St. Thomas with a T-square; and the others must be Matthew, Jude and Simon, and beyond them prophets beginning with Ezekiel.

St. Thomas has a T-square because he is said to have been an architect, and at Semur-en-Auxois we have his legend, which may serve us as a type of many of the mediæval legends. In the tympanum of the north door at Semur, beginning on the left, we see him—(1) Putting his hand into Christ's side; (2) The Provost of Gundoforus, King of India, meeting him in the market-place at Cæsarea and engaging him to go to India to build his master a palace; (3) St. Thomas and a disciple going in a boat to India.

Line 2, from right, shows Thomas arriving during the wedding feast of the king's daughter, where a dancer is walking on her hands. St. Thomas has just cursed the king's cupbearer who tried to prevent his entering; so dogs had eaten him, and one is running in with his hand in his mouth. St. Thomas receives orders and money for the palace from the king, who is going off to war. He gives the money to two beggars, one on a stool, the other, a negro, holding a calabash. St. Thomas is put in prison, but escapes and tells the king, who is kneeling before him, that a more beautiful palace awaits him in heaven if he will be baptised.

These apocryphal legends are much commoner in the cathedral carvings than the true Bible stories; but they are sometimes mixed with them as at Rouen, where on the north door the death of John the Baptist is shown on the lintel and Salome is shown tumbling as at Semur. In the upper part disciples are shown gazing into an empty tomb, the story being that St. John the Evangelist had a grave dug in front of the altar, lay down in it, in a dazzling light, and when the light had faded the grave was filled with sweet smelling manna in place of the body of the Apostle.

But the most perfectly executed of these stories, whether true or imaginary, are to be found in Paris in the story of St. Stephen on the south door, and in that of St. Theodore.

There is also a wonderful set of panels (of about 1275) on the south side of Notre Dame which represent either the life of some unknown saint, or perhaps, though it is less likely, scenes from the turbulent life of the students of the University of Paris in the thirteenth century. If that is so, we have (1) the students quietly taking notes of a lecture; (2) standing round a professor, who is addressing them from a high dais; (3) probably a riot amongst the students; (4) the young men being hauled up by the Proctor before the Vice-Chancellor and taking an oath to behave themselves better in future.

The plinth of Amiens is covered with quatrefoils, in which are the Virtues and Vices and the Labours of the Months, and in the other porches and on the buttresses where the statues represent the prophets a little scene is given from the book of each. Thus Ezekiel sits before a little wheel. They are pretty enough, but probably the sculptors had never read the books themselves.

Let us now pass to what was the crown of beauty of French mediæval art—Reims.

The whole interior of the west wall is covered by seven rows of niches, divided by panels of most beautiful foliage and each containing a statue. The drapery of these figures is of the most masterly design and execution, with large ample flowing folds. The Communion of the Knight is sometimes called Melchisedek and Abraham, and I believe that is right, and that it was not ignorance that represented them as figures of the time, but the wish to bring home to the people the fact that the great teaching of God's Word is for all time. In our modern efforts to represent sacred scenes as they were we often lose the spiritual lesson. In some of these figures, however, as in that of Joachim, there is an exaggerated inclination to bend and turn the figures.

The whole exterior was an inexhaustible mine of glorious sculpture. On the buttresses of the apse are figures of adoring angels, all different, invariably beautiful, graceful in attitude and noble in proportion, young and gracious, with a calm and holy joy, intelligent, delighting in their work; and the great statues in the buttresses on the south side are not less admirable. By the rose on the north transept is a charming Eve. She appears, however, to have made a pet of the dragon which she is carrying and stroking. But the west front is the glory of Reims. On the centre porch, the artist has given his figures a life and interest as well as beauty not found even at Amiens. They are combined in groups—the Annunciation, the Visitation, the Presentation. The way in which they turn to each other has in it much of the graceful action of intimate home life. In the

Annunciation the angel is turning with extreme grace to the Virgin, and in the Presentation the venerable Simeon is stretching out his arms with gentle kindliness to receive the infant Christ. The drapery again is masterly in its contrast of grand "sweepy garments vast and bold," with delicate folds on other figures, such as the aged Elizabeth. The northern portal is hardly less fine: the two angels on the left-hand side nodding confidingly to St. Nicaise between them were delightful. Now, alas! they are ruined for ever.

The centre gable represents the Coronation of the Virgin, the northern one the Crucifixion, but both were badly restored in the eighteenth century.

In the north transept are two doors. On the centre one we have the life of St. Nicaise, beheaded by the Vandals, with his sister, St. Eutropia, at his side and on the left, kneeling carrying his head, with an angel censing, and another behind. The whole scene is quite perfect in design and execution.

I propose now to take two subjects and sets of statues and trace them down through the centuries as represented in French sculpture—The Life, Death and Coronation of the Blessed Virgin and her statues; the Last Judgment and the figures of our Lord.

At Senlis is the earliest representation of the complete legend of the Coronation. The Apostles who were dispersed through the world suddenly felt themselves drawn together by a mysterious force which brought them into Mary's room where she lay awaiting death. In the third hour of the night Christ came with sweet melody and song, and in the morning her soul issued out of her body and fled up in the arms of her Son. After the burial of the body the Apostles watched by the tomb three days. On the third day Christ, with a multitude of angels, came to raise the body of His mother, and her soul came again. Thus at Senlis and Notre Dame we see the angels, trembling with reverence, gently bear up the body, which is too sacred for them to touch, on a long veil. Then follows the Assumption, and when borne by angels Mary reaches heaven, Christ seats her on the throne at His right hand and places a crown on her head.

At Laon we have an almost similar but inferior treatment of the same subject, probably copied from Senlis.

Next comes the south doorway of Notre Dame, which was in the old cathedral and replaced, slightly altered, when the cathedral was rebuilt. It is of late twelfth century date. When rebuilt it was raised and a new lintel added. It gives the history of St. Anne and St. Joachim, but a good deal mixed up with that of the Virgin and St. Joseph. Above is the Virgin enthroned. with the Child on her knees. Very Byzantine in character, she is seated, and the Child. standing on her lap with His hand upraised in blessing, is the chief and most conspicuous figure. On her left is a king, probably Louis VII., father of Philip Augustus, kneeling. On her right a bishop, standing, probably Maurice de Sully, the founder of the present Church. The elongated figure on the pier is St. Marcel.

The later north door, the Virgin's door, is perhaps the most perfect work left us by the thirteenth century. On the centre pier is the figure of the Virgin restored, but from the original which had been preserved at St. Denis. She stands on the dragon, with Adam and Eve and the Tree of Knowledge. Above her head is the Arch of Alliance, a name given to her in many mediæval litanies, as she is the link between the old and new dispensations. On the lintel are three prophets, who foretold her coming; three kings, her ancestors, on the left; on the first four voussoirs, angels censing. On the second tier comes her resurrection, treated as at Senlis. Two angels, trembling with reverence, lift her from her tomb and bear her gently on a veil; Christ, standing by the side of the tomb, is calling her to Himself, and the pensive Apostles meditate on the mystery. Above is an angel placing a crown on her head, and Christ with His hand raised in blessing. The attitudes are perfectly natural and graceful, the faces expressive and calm.

As a rule, the Blessed Virgin Mary is treated as a Queen throughout the thirteenth century, and all the emblems which are given her are those of majesty and mystery; she stands on the Burning Bush at Chartres, sits beneath the Arch of Alliance at Paris, and carries in her hand the rod which budded. But gradually this idea seems to remove her too far from sinful men who needed help. At Amiens, in the older of the two statues, she is carrying the Child on her left arm like an ordinary baby, though He holds the sphere in His left hand and is still blessing with the right: she is less the queen than a noble lady holding out her right hand as if granting a request. The other statue, the Vierge Dorée, is a charming mother playing with her Child, Who is looking at her, not out on to the world; the sphere has become a ball held in both His hands. This is perhaps the finest of all the statues of her—the modelling

of the head is perfect, the hands beautifully carved, the draperies grand in their broad simple folds. A little later, as in the Vierge de Riom, the idea of divinity seems almost to have disappeared in the laughing mother playing with the lively romping Child, and later still she becomes simply the young girl-mother looking lovingly at her little swaddled baby, as in the Virgin of Autun.*

Yet, at the same time, the sense of the infinite suffering of the mother of the Lord was growing, and on the remains of the eighteenth-century choir screen of Chartres, in the scene of the Nativity, she is represented leaning over and timidly touching the Child Who is laid, not in a manger, but on an altar in front of her. In the scene of the Presentation the dignity of the whole group is very striking, and the exquisite expression in the hand of Joseph guiding her from behind makes one feel more angry than ever with the barbarism of the eighteenth-century clergy who broke up this masterpiece and used it as paving stones.

Later still, in the fourteenth century, the time of the Hundred Years' War, the Jacquerie and the Black Death, life became unbearably sad, and the mother of the Lord became the Mater Dolorosa, Our Lady of the Seven Dolors, the Martyr of Martyrs. So in the last great works of French sculpture, the fifteenth-century groups at Solesmes, melancholy is the prevailing expression of all the faces, exquisitely beautiful but full of heart-rending grief.

Let us end by seeing, in a similar way, how the thought of judgment and the idea of the Saviour passes away from the terrors of the Apocalypse to express the divine love of the infinitely sad Saviour of mankind. At Autun the Christ who presides at the Judgment is not yet "The Son of Man." By His side is an angel weighing the souls, and a devil waiting for the lost, while an angel with a large sword keeps them off from the elect. In the lintel is the Resurrection, the saved clothed and looking up to heaven, the lost naked and weeping. Above, an angel is passing the souls of the blessed, one by one, through a window into a palace which represents Paradise. Barbarous as it is, it is full of life and dramatic feeling.

Laon, a later work, is crowded and confused and much less vigorous; but here for the first time Christ is not only Judge but the Saviour, showing His wounds.

The door of the north transept at Reims shows an immense advance. The figure of the enthroned Saviour is solemn and grand, and the drapery truly antique in its arrangement; St. John and the Blessed Virgin Mary on either side are raising their hands in humble supplication, and two angels with emblems of the Passion are kneeling behind them. The Resurrection of the Dead is depicted in two strips of relief with such life and variety that the twenty-nine little figures, in different and often very naive positions, express at once, with the utmost skill and perfect reverence, the act of raising the coffin lid and clambering out of the tomb, and at the same time astonishment, fear, pious resignation, and earnest prayer. Below are seated figures of blessed saints on the right of the Saviour; on the left the lost—partly destroyed. Below again, the lost souls are being dragged away by Satan, and the saved souls being presented to Abraham by angels, two of whom, in the most delightful way, are presenting two souls on a pair of napkins.

But finer than this in its original state was that at Paris. The lintel is modern, but the rest, though restored, is the original work. The expressions, especially the terror and despair of the lost, are very finely rendered. In the upper part is Christ, showing His wounds; the two angels with the instruments of the Passion, the Virgin, and St. John on their knees. The grouping of the figures at the top is perfect. Christ, larger than the others, is in the centre, two angels stand by His side holding the implements of the Passion, and the kneeling figures of St. John and the Virgin fill the corner spaces; but the most wonderful thing is the filling of the tiers of arches. Note the calm and breadth of the work, especially of the angels, and with the heavenly calm of the blessed contrast the rush and whirl of the other side. Note especially the horsemen of the Apocalypse, famine, and, most of all, Death. He who rides on the pale horse is here shown as a woman with blindfolded eyes. She has leaped in front of a man and stabbed him with a huge knife, so that he has fallen backward over the horse, dead and limp, while she, clinging tightly to the creature's neck, is making him rush on with outstretched head in an agony of terror.

True as the Judgment scene of Amiens is, it is confused and crowded, and does not come anywhere near the simpler beauty of that of the north transept of Reims, still less to the perfection of Paris. One alteration in particular is far from being an improvement on either. At Reims the two angels and St. John and St. Mary

* In the collection of M. Rerolles, to whom I am indebted for a photograph.

are all kneeling; at Paris the angels are standing, and St. John and St. Mary are beyond. It did not seem right for the angels to be kneeling in the former, and the two intercessors seemed too far removed from the judge in the latter. So the sculptor of Amiens placed them with outstretched arms on either side of Christ that their intercession might be irresistible. The innovation was affecting, but not happy from the point of view of art, for it was necessary to reduce the height of the angels to get them within the arch, and the result is a straight line, instead of the pyramidal arrangement which was needed to fill the triangle.

Here, first, we have the figure of St. Michael prominent. He weighs the good actions of the soul waiting by his side in one scale, its sins in another. But here, to teach the lesson that it is salvation by Christ and not man's own good works that save him, the Lamb is in one scale, in the other the head of a demon, while another demon is trying to push up the good scale.

That which is usually reckoned as the finest is the great west door of Bourges, but it has the fault of Amiens of being too crowded. The St. Michael is a charming figure, and so is the whole group of the elect making their way to the Gate of Paradise where St. Peter is sitting, representing the Church which alone has the power through the Sacraments to admit men to eternal life. Here, as at Amiens, the first to enter is a Franciscan with his triple knotted cord; the next, a king carrying the flower of a saintly life, St. Francis of Assisi, and Louis IX., slender as a knight and beautiful as an angel, who had just died. This tendency to confusion goes on increasing. We see it in the Cathedral at Rouen, and still more at St. Maclou, where, however, there is a marvellous piece of imagination described by Ruskin in the figure of the flying angel driving the lost before him, right out of the tympanum into the niches which are represented as all on fire, with a little demon in the roof of each grinning down on the lost soul below.*

Never was the soul of a people so revealed as in the great cathedrals of the Middle Ages and their marvellous sculpture. To the men of the time they spoke with a thousand voices. In them the creative power of the artist made a garland of all living things to adorn the house of God. Plants, animals, all these beautiful creatures that awaken curiosity and tenderness in the heart of the simple and the child, there grew beneath his magic touch. And there was given the key to the riddle of life, its conflict, its struggle with Nature through the labours of the months, the constant battle in the heart of every man between the evil and the good, the teaching of the prophets, the salvation through Christ, the final Judgment, and to those who have fought a good fight the angels of the heavens above hold out crowns. Conviction and faith pervade the cathedral from end to end and tell their story with a thousand tongues. Even the widest of us moderns must hear some echo of those silent voices, see some of the wondrous visions which they saw and left carved in the stone for us to learn by.

Just a few words of that lesson I have tried to set before you in hopes that you may dip further into the deeper thoughts which lie there. You will have noticed the steady change which takes place in the representations of the Blessed Virgin, of the Last Judgment, and of Our Lord—how from being only the Queen of Heaven crowned by her Son, she becomes the Majestic Matron, then the Human Mother rejoicing over her Child; in the fourteenth century the Mater Dolorosa; and, finally, in the fifteenth century and in Italian Pietás the desolate widow carrying the dead body of Christ. In the Last Judgment, and in the figures of our Lord, the stern Judge of the Apocalypse of Autun becomes the Christ showing His wounds of Laon, then the severe but pitiful Saviour of Chartres and Amiens, and the purely loving and gentle Beau Dieu of Reims, which is a work of such beauty that it may reckon as the most perfect of the most perfect period of mediæval art. It shows admirable understanding and execution of the whole form in faultless proportions, and there is such beauty in the mild calm expression of the face, that it is even finer because stronger in expression and attitude than Leonardo da Vinci's.

But gradually, as in the case of the Blessed Virgin Mary, the figures grow sadder, and later the Saviour is generally represented on the Cross, as His mother is with His dead body on her knee. But, as a transition to that, the last stage, one of the most beautiful but saddest figures of the Saviour that I know is at Troyes. What is the secret of all this? I think it is this. When the Roman world was crumbling to pieces, St. Augustine bade the suffering people look up from the perishing City of Man to the eternal City of God. They needed the assurance of the justice of God overruling the injustice and cruelty of man, that there was a divine and lasting order over and behind the shifting

* Ruskin, "Seven Lamps of Architecture."

anarchy of the world. So the idea of the great Judge and trust in the stable organisation and all-embracing knowledge of the Church were what appealed to them most. The answer to that appeal was given. That is what we find in the earlier work, in the all-embracing encyclopædic sculpture of the Church, and in the great picture in St. Croce of the Feudal Empire and the Church ruling the world side by side.

But as the world settled down and life became orderly and joyful once again, and the tenderer, womanly side of human nature was able to show itself, the love of the Virgin Mother and of the Saviour wounded for our transgressions were what found the readiest echo in the hearts of men and women. But with the fourteenth century the joy of life was clouded over again, and the sadness of the Mother for the dead or dying Son became the pity for which each individual soul was crying out, and the sorrow of the Crucified One was most in touch with the sadness of man—men no longer wanted to point, Lo here or Lo there is the orderly Kingdom of God; each man wanted to feel for himself the Kingdom of God was within him, and to have the Saviour for his very own. It was in answer to that sense of personal need that the great upheaval of the Reformation came about, and the outward material message made visible in the beauty of art became the inner invisible spiritual voice speaking in the soul of every man.

THE WORKMAN'S SHARE OF PROFITS.*

The workman says that he should have his share of the profits. What is his share under the present state of things? The average capital expended in an engineering works per individual employed is about £200. An investigation the writer made some years ago gave this figure, and it was confirmed by an investigation of shipbuilding yards, which gave £185, and of the Census of Production, which gives a capital of £1,500,000,000 for 7,000,000 workers, or £214 per man. An investigation of the dividends paid shows them to be about 4 per cent. on the capital employed. Here it must be remembered that firms paying 10 to 15 per cent. on their ordinary capital have often a large preference and debenture capital, on which a much lower rate of interest is paid, and also that often part of the ordinary capital was issued at a premium. Also account has to be taken of the large number of companies that do not pay any dividend on their ordinary stock, and often none on their preference. Little is as a rule heard of the finances of such companies; it is the ones paying good dividends that public attention is drawn to.

It thus means that the shareholders get about £8 per year per individual employed.

On the other hand, the average wages for men and boys, skilled and unskilled, is about £70 per annum in normal times. This means that the worker gets between eight and nine times as much as the capitalist, and shows on what a very small margin the capitalist works. And without the capitalist, under our present system of individualism, there would be no factories erected and run, and therefore no work for the working-man—a thing it is well for him to remember—and also that without profits the capitalist will not invest in engineering and other works in this country, but will seek for a more profitable field for his capital elsewhere. Every £200 invested in this country in a factory means work and livelihood for one British working-man.

At the same time I am sorry to say the employer does not look after the welfare of his workmen as he might. In a small factory the head of the firm, as a rule, knows all the leading men among the workmen, many of them having been with him for years. As the place grows he loses touch with his men, and as an actual fact knows fewer of those under him when he has 1,000 or more employees than he did when he had 400 or under. This state of things gets worse when the place is turned into a limited liability company, as nearly all large places are at present. The result is that a most deplorable state of things has come to pass. The workman says, "Put not thy trust in employers"; the master says, "Put not thy trust in workmen"; and the official who is between the master and the workman says, "Put not thy trust in either."

It is difficult to say what is to be done to remedy this state of things, but one cannot help feeling much might have been done in the past to have prevented such a regrettable state of affairs as there is at present. Much of this trouble might have been avoided if employers had shown more consideration for the welfare of their workmen. Of course, there are some notable exceptions, but they are few and far between. An example is the necessity of the Factory Acts to ensure proper light and air and other arrangements necessary for the health of the workmen. But much more should be done. Why is it that canteens are being rushed up all over the country, and why were there so few before? In many works to this day the provisions for getting food and drink warmed are most primitive and inefficient, and as to getting anything to eat if one has to work overtime unexpectedly, it is in most works impossible. As a rule, the only thing available was a drink at the public house outside the gates, and even this is now closed at five o'clock. Why, if a man works overtime, should he also starve? And how can efficient work be expected under such conditions?

* Extracted from the address to the Engineering Section of the British Association at Newcastle-on-Tyne by Gerald Stoney, B.A.I. (Dublin), F.R.S., M.Inst.C.E., President of the Section.

Why also should there not be provision for drying clothes after walking to work on a wet morning, and each man be provided with a cupboard where he could keep a change of boots? Why are not sanitary arrangements decently private, and why are they not kept clean and wholesome. They are often in a disgraceful state. These are only a few samples of the directions in which much might be done.

The adjustment of the wages to be paid to the workman is a most difficult one. There are three principal ways of paying workmen—on time, on piece, and on bonus.

On time is the only way of paying a man who is on various classes of work, where the fair time required for each job is not known, and in many cases the most highly skilled men are on such work and as a result only make time wages. This results often in the highly skilled man making less money than the less skilled man who is on repetition work and as a consequence is working on piece or bonus, and this is obviously unfair. For example, a man may have the setting up and adjusting of a number of machines on repetition work, and he often makes less money than the less skilled men under him who are on piece or bonus, although their nominal rate of wages is less than his.

Again, highly skilled erectors who go outside the works to erect machinery, often worth thousands of pounds, and set it to work, are only paid on time, and often make less money than their fellows who are on piece inside the works.

The adjusting of piece prices is a most difficult one. They should be adjusted so as to be fair both to master and man, but too often such fixing of prices is left to subordinate officials who have in many cases their own axe to grind. There should in every works be a special department for such fixing of prices, and once a price is fixed it should not be altered without good reason. The practice of cutting prices by the masters in the past is, in the opinion of the writer, largely responsible for the present limitation of output by the men about which we hear so much. There is a rule that if a man makes more than time and half or time and third the price of the job is to be cut. If the price has been fairly fixed why should it be reduced because the man makes large wages due to his skill and industry? The larger the output from his vice or lathe the better for the master, as he is getting a larger output from his plant with a certain capital expenditure, and thereby establishment charges are reduced. This is especially the case in machine work, as the hourly value of the machine employed often far exceeds the wages of the workman employed.

A fair rating for machine tools is 4*d.* per hour per £100 value, and as the time rating of the man is generally about 9*d.* it is easily seen that if the average value of the machine tools exceed £225, machine charges exceed time wages, and the average value of machine tools is generally largely in excess of this figure, in fact often about double it. It is therefore obvious that it is much more important to get large output than to pay small wages.

The result of this "time and half" rule is that a good man by working up to the limit of his capacity "spoils the job" for the next man who comes along, and may not be of the same calibre as the first man. It has therefore been found advisable and necessary by the workmen to limit the output of all men to a certain standard, and this results in the end by the pace being set by the slowest man on a particular job.

A fair bonus system is perhaps the ideal way of paying men; but here, again, although the times for a job are supposed to be fixed and unalterable, in too many cases they have been altered by various devices, and as a result the system is looked on with suspicion by the workman.

Gradually bit by bit the pernicious doctrine that the less work done by a man the more employment there will be has grown up, he not seeing that the cheaper an article can be produced the larger will be the sale for it and the better it will be able to compete with the products, not only of other producers in this country but of those abroad. And also that very cheapness, combined with good quality, induces the sale for such articles to be large.

Laziness is inherent in man, and *on an average* no man will work unless compelled to do so, and still less will work his best unless there is a great inducement. This is true not only of the working-man but of all other classes. Therefore the policy of "Ca' canny" has been only too readily adopted on the ground not only that it was pleasant for the man himself; but also he believed that it tended to the welfare of his fellow-workmen.

The writer has very reluctantly come to the conclusion that the workman of to-day is not doing as much work as was done some thirty years ago when he was in the shops, and not only this, but that timekeeping is not as good. In this connection, however, it must be remembered that excessive overtime inevitably leads to bad time-keeping.

FUR FARMING IN CANADA.

Attention was drawn in the *Journal* of March 21st, 1913, to a new industry which had sprung up in Prince Edward Island, viz., the breeding of silver foxes for their pelts. Some striking figures were quoted as to the value of the animals—*e.g.*, in 1911 prices rose to £1,000 a pair, and towards the time of littering in 1912 one pair sold for £4,000, while in the closing months of 1912 the prices had risen even higher. Further particulars of this industry are now given in "Canada, the Country of the Twentieth Century," a book published by the Department of Trade and Commerce, Ottawa. Owing to the value of the pelts, the demand for silver fox pups became so great that prices

steadily increased, and at the time when the war broke out five months' old pups of the best Prince Edward Island stock were selling at from $12,000 to $16,000 per pair, while old stock of proved fecundity realised as much as $35,000 per pair. When the pups could be bought at prices ranging from $1,000 to $4,000 per pair a number of farmers started fox ranches, but when the price rose to $10,000 and more it became impossible for the ordinary individual farmer to embark on the industry, and joint-stock companies were started. In April, 1914, there were in the island 194 joint-stock companies which had been organised for the purpose of breeding fur-bearing animals, chiefly silver-black foxes. These companies had an authorised capital of $31,232,700, but a number of them have not yet been floated, and probably not more than half the stock has been actually issued. Besides these companies, about three hundred individual farmers are registered as having ranches for breeding fur-bearing animals. Karakul sheep, from which the well-known Persian lamb skins are obtained, have been imported into the island by some of the fur farmers, and promise to do well. The breeding of red foxes, crosses between silvers and reds, blue foxes, minks, otters, and skunks, is also being undertaken by some farmers who cannot afford the high prices demanded for pure silver fox breeding stock.

Very few silver fox pelts have been sold in the island in recent years, owing to the great demand for breeding stock; but it is generally agreed that as the foxes on the ranches are rapidly increasing, the industry will come down to a pelt basis in a few years. It has been estimated that if prices keep up long enough to enable farmers to get back the money they have invested in fox-breeding, they could afterwards make good profits by raising silver foxes for pelts if the price of pelts should fall as low as $60. As regards the prices of silver fox skins in 1914, Mr. J. Walter Jones, who was selected by the Canadian Commission of Conservation to make a special study of the whole question of fur farming, writes: "At the present time the average price of wild silver fox skins in London is about two hundred dollars, and for ranch foxes, such as are found with the best ranchers, twelve hundred dollars. Wild silver fox skins are not always prime, and they are frequently shot, chewed, mangled and poorly dressed, while ranch foxes are usually killed when their fur is in prime condition. The highest price ever paid at the London sales for a silver fox skin was $2,900. It is said that this skin was sold by a Paris firm which had bought it at a previous sale for $1,950, and that it was from a ranched fox from Prince Edward Island. The next highest price was $2,700, and half a dozen have sold for $2,500 or more, all being from Prince Edward Island ranches. A remarkable sale was made in March, 1912, when a pelt from a fox that died in James Rayner's ranch at Kildare, Prince Edward Island, on October 12th, 1911, brought the highest price, $2,050, although the skin would not have been fully prime before December."

The fox-breeders of Prince Edward Island claim that the climate of this district is more favourable to foxes than any other known locality, and the prices realised at London auction sales would seem to bear out their contention. Other provinces in Canada, however, are following the example of the island. Up to April, 1914, Nova Scotia had issued fur farming permits to 205 individuals, 36 partnerships, and nine joint-stock companies, while 46 joint-stock fur farming companies had been incorporated in the province. At the same date 42 joint-stock fur farming companies had been incorporated in New Brunswick, and 27 permits had been issued to individual farmers. In Quebec Province fur farming permits had been issued to 21 firms and companies. In Ontario 30 fur farmers were registered; in Alberta nine fur farming companies had been incorporated; in British Columbia, two; and in Manitoba, one.

HORTICULTURE ON THE NILGIRIS.

The Annual Administration Report of the Government Botanic Gardens and Parks on the Nilgiris for the last official year contains some interesting information regarding efforts that are being made to improve fruit-growing on the hills. Surprise has often been expressed that the Nilgiris, which possess a climate so admirably adapted for the growing of all varieties of fruit—those of temperate regions as well as sub-tropical varieties—should be less well known for its fruit-growing than many places in one respect or another less favoured, such as Saharanpur, the Kulu Valley and Quetta. The reason for this seems to be that the efforts of the past have been mostly those made by private enterprise; they were spasmodic and uncontrolled, so that a promising start was not maintained. In course of time deterioration and degeneration set in, because little or no attempt was made to renew stocks, to introduce new varieties, or by plant-breeding to improve existing varieties. This applies both to the English fruit and vegetables for which Ootacamund and Coonoor and the other Nilgiri stations were once reputed. For instance, the jargonelle pears many years ago were large, luscious and delicious, and the same might be said of the two varieties of plum grown on these hills. Recent specimens of these fruits, says the *Madras Weekly Mail*, prove how they have degenerated. The Nilgiri Horticultural Exhibitions have done much to encourage horticulture and agriculture on the hills, but a great deal remains to be done.

According to the report, several choice

varieties of apple trees have been imported from South Australia, and ninety of these have been planted in the orchard in the Government Botanic Gardens, where they are thriving. The remainder were either sold to the public or planted in the orchard in Sims' Park at Coonoor. For this purpose the plantation in this park had to be cleared to provide more orchard land. In addition to the cherimoyer and the Chinese guava plots which have already produced fruit, these orchards will contain the apple trees already mentioned, peaches of several choice varieties, pears, oranges and almonds. This stocking has been going on for the past three or four years, and the experiment seems promising. When we get to the Burliar and Kullar experimental gardens, we reach a zone where the temperate climate fruits and plants give place to the tropical and sub-tropical varieties. Burliar is already known to fame as the first place in Asia, outside the Malayan archipelago, where the mangosteen and the nutmeg have prospered and produced fruit. The mangosteen crop during the year under report was a poor one, but an excellent crop of nutmegs was harvested. As there was no market for these in India, they were sent to England for sale; but the profit on the consignment was almost nil owing to high freight and other incidental charges. For the first time after its introduction in 1898 the durian has fruited. It produced a single ripe fruit of good quality. The durian trees in the gardens have flowered on several occasions, but have never set their fruit before.

PROPOSED NEW RUSSIAN RAILWAY.

The *Board of Trade Journal* contains some particulars of the proposed Obi-Ural-Bielomorsky Railway, which has been projected by the Minister of Finance and the Minister of Ways of Communication, and approved by the Russian Council of Ministers. Starting from Archangel, the line will be built to Pinega, and traverse the Ukhtinsky district, crossing the River Petchora, near the village of Troitzko-Petshersk, and will thence proceed to the port on the Obi River, in the vicinity of the Chemashevsky settlement. After the railway has crossed to the eastern slopes of the Ural Mountains, a branch line will be built from one of the stations to the Nadeshdinsky works of the Bogoslovsky Railway. The total length of the line will be about 1,000 miles.

As the railway will pass through the dense forest districts of the basins of the Mezen, Petchora, and Obi Rivers, it will greatly facilitate the exploitation of these parts, and will thereby increase the revenue of the Forestry Department, as well as promote the export trade in timber. It will also provide a cheaper route for the exports of raw materials, chiefly grain, from Siberia; and it will connect the mining districts of the north-eastern slopes of the Ural Mountains with newly-discovered rich deposits of iron ore and mineral fuel. By opening up a route to a country so rich in natural resources, but hitherto almost inaccessible, the new line will make it possible to establish factories in this territory, so that many articles now imported may be manufactured within the district.

TANNING MATERIALS IN MALAYA AND NORTH BORNEO.

A correspondent, writing in the Imperial and Foreign Trade Supplement of the *Times*, says it is a mistake to suppose that the quebracho tanning extract produced in Argentina and Paraguay, largely under German auspices, is indispensable to the British tanning industry. Quebracho extract is a very good and useful tan, and possibly some tanners in this country who are accustomed to use it would object strongly to any obstacle being placed in the way of its importation; but the fact is that the British Empire is quite capable of producing within its own borders sufficient tanning substances for its own requirements, and many excellent opportunities exist for the employment of capital and energy in the manufacture of tanning extracts at the places where the raw material grows.

The Malay Peninsula, which has come much into public notice in the last ten years, could contribute largely to the world's requirements of tanning materials. For example, on the coast of the States of Perak and Selangor there is an area of about 250 square miles of mangrove forest. At present this is a Government reserve forest and is worked for firewood only. It contains six species of mangrove suitable for the production of cutch or extract, and the bark is so far a waste product, with the exception of a small quantity used locally for dressing fishing nets and sails. The Governments of the Straits Settlements and Federated Malay States are ready to encourage the starting of new industries, and a good opening is here presented for the establishment of a mangrove extract factory.

Good progress is being made in the manufacture of mangrove cutch in British North Borneo, and the exports of extract have expanded both in quantity and value during the past year. In Borneo, as in other tropical countries, supplies of mangrove bark are practically inexhaustible, and factories erected in suitable localities can obtain their requirements of bark from the immediate neighbourhood for many years without depleting the supplies. The process used in Borneo for preparing mangrove cutch is simple. The freshly gathered bark is tied in small bundles and boiled in vats until the soluble matter has been extracted, which is ascertained by determining the density of the decoction. The spent bark is taken out, allowed

to dry in the open, and used as fuel. Concentration of the extract by evaporation is carried out in vacuum pans similar to those used in sugar manufacture. The extract is concentrated to a syrup, which on cooling hardens to a resin-like solid.

ARTS AND CRAFTS.

The Design and Industries Association.—The Design and Industries Association is showing further signs that it is an organisation which has come to stay. It has just issued its fourth pamphlet, "A Modern Creed of Work," by Mr. A. Clutton Brock; and in "The Beginnings of a Journal of the Design and Industries Association" it has published the "forerunner" of a regular periodical dealing with the doings of the Association. This, in war time, is no mean achievement on the part of a body which was only inaugurated in May, 1915. Further, Mr. Clutton Brock's paper is a statement of the aims of the Association, not only written as we should expect him to write it, but embodying a singularly sane, sensible, and at the same time noble, ideal, and pleading not merely for the joy of handwork (such pleas have been abundant in recent years), but for recognition of the fact that to do any piece of work really well is in itself a joy. What is wanted is not so much any particular form of work as a spirit of adventure and of life running through the work of the community. It is surely a recognition of the possibilities of the machine at least as much as a revival of home and peasant handicrafts towards which all lovers of art ought to turn their faces to-day. That there is a charm and a quality about good handwork which is lacking in goods produced by machinery is indeed true. But the best machine-made wares have also certain qualities of their own, and at the present moment there is a fairly plentiful supply of objects which hide under the convenient cloak of peasant art a deal of bad craftsmanship. Further, there is a certain amount of aping of handmade characteristics in machine-made goods which is truly reprehensible. In the face of all this, it is cheering to see that a society, which sets before itself the aim of harmonising "right design and manufacturing efficiency, accepting the machine in its proper place . . . as a device to be guided and controlled, not merely boycotted, by those interested in the production of worthier and more beautiful things," is making good progress. The announcement that the Arts and Crafts Exhibition Society have placed a space at the disposal of the Design and Industries Association at their forthcoming exhibition at Burlington House, and that the Association proposes to show a collection of domestic pottery and china is a very welcome piece of news. The Arts and Crafts Society has not always been noted for the judicious selection and arrangement of its pottery exhibits, and the Design and Industries Association includes amongst its members one or two men at least who should be able to ensure that the proposed show of ceramics will be up to a high standard as pottery no less than as art. Perhaps there is no branch of manufacture in which the cry for handmade or hand-finished work has led to more unsatisfactory results. This is peculiarly unfortunate, as the pottery trade, besides being an important British industry, is also one which does a considerable export business, not only with Europe but also with America.

Handweaving and Embroidery.—Handweaving and embroidery have been much talked about lately. For some time past, of course, they have been in the forefront of the industries associated with the Home Arts and Industries Association and the Peasant Arts Association, and weaving has, further, been suggested and tried with some success as a suitable form of employment for the crippled and the blind. Now it is being further urged that hand-loom weaving is an excellent occupation for girls who have made shipwreck of their lives, and that embroidery offers a good opening for wounded sailors and soldiers, many of whom are wonderfully skilful with their fingers. There is, no doubt, a great deal of truth in all this. The two crafts are obviously within the capacities of those who it is suggested should be encouraged to practise them, and there is, moreover, a certain demand for such work. On the other hand, there seems to be a very reasonable doubt whether that demand is capable of very much growth, or whether even it may not be slightly artificial—the outcome of a desire, sincere enough but not necessarily very strong or persistent, to help forward some pet scheme or other, rather than to possess or use hand-woven or hand-embroidered fabrics. We have to bear in mind that such materials are, in the twentieth century and in this country, rather in the nature of luxuries. They are bought, not because they wear longer than machine-made goods, but because to some people they are more pleasing, and therefore worth paying more for. At the moment people are willing in the interests of a cause to buy them, but it seems doubtful whether, with increased taxation and the higher cost of living, this state of mind can go on indefinitely. It is still more improbable that it will spread to larger sections of the community. Again, we have to remember that it is not only the conditions of life in our own country which have to be considered. Before the war there was enough interchange between the various countries of Europe for Russian, Scandinavian, Italian, and other peasant work to find a market in this country. The little exhibition held in June at Cromwell Road, of the work

done by the Serbian refugees at Corfu, which consisted for the most part of very interesting and characteristic peasant embroidery, served to remind us that after the war we shall in all probability be confronted with work from the Balkan States. Again, Transylvania and some of the Slav districts of Austro-Hungary, though comparatively few English people seem to realise it, are extraordinarily strong in peasant embroidery, and in all these lands labour is comparatively cheap. There may possibly be an increasing opening in this country for the practice of hand-loom weaving and embroidery, but there is certainly the danger that such work will tend to be paid at a rate which will bring it within measurable distance of sweated labour. It is to be hoped that philanthropic folk will pause and consider the possibilities before they encourage any considerable number of people to turn their attention to these occupations.

GENERAL NOTES.

The Institute of Metals.—The annual autumn meeting of the Institute of Metals will be held on Wednesday, September 20th, commencing at 4 p.m., in the rooms of the Chemical Society, Burlington House, Piccadilly, London. Sir George T. Beilby, F.R.S., LL.D., will preside, and a number of important metallurgical papers will be presented and discussed. These include: (1) "The Allotropy of Silver," by Dr. W. D. Helderman (Utrecht University, Holland); (2) Note on "Cadmium in Spelter," by W. R. Ingalls (New York, U.S.A.); (3) "The Annealing of Arsenical Brass containing 61 and 62·5 per cent. of Copper. A Study of the Structure and Properties Developed by Varying the Rate of Cooling within the Transformation Range," by C. H. Mathewson and E. M. Thalheimer (Yale University, U.S.A.); (4) "The Development of the Spelter Industry," by Ernest A. Smith, A.R.S.M. (Sheffield).

The "Englishwoman" Exhibition of Arts and Handicrafts.—This Exhibition will be held at the Central Hall, Westminster, from November 15th to 25th. There will be exhibits of hand-weaving, wood-carving, stained glass, embroidery, lingerie, enamelled glass, pottery, statuettes, water-colour drawings, etchings, calligraphy and illuminating, miniatures, jewellery, pewter, lace, toys, model buildings, leather work, Armenian needlework, silver and metal work, feather work, antiques, gardening, dressed dolls, Chinese lacquer, bookbinding, tapestry rugs, hospital supplies, basket work, bead work, hand-painted buttons, artificial flowers, bread-making, war relics, sweets, needlework, stencilling, artistic dress, etc.

A Tree-felling Steam-saw.—A description is given in the *Engineer* of a tree-felling steam-saw made by Messrs. A. Ransome & Co. It consists of a steam cylinder 5 in. in diameter and 19 in. stroke. It is pivotally attached to a light wrought-iron frame of triangular shape, so that the saw can be fed up to its work by means of a hand-wheel worm and quadrant, the latter being attached to the cylinder. The saw-blade is fixed to the piston-rod and the teeth are designed to cut on the inward stroke only. During some tests recently conducted steam at 100 lb. pressure was obtained from a portable 2 ft. 9 in. by 6 ft. 3 in. Spencer-Hopwood water-tube boiler, through the medium of flexible metallic tubing, covered with felt and canvas to minimise condensation. Some Scotch fir trees were selected, of about 24 in. in diameter. The process of felling each tree occupied only some three or four minutes, and it is claimed that one machine, attended by a gang of four men, will do more work than thirty woodmen.

Cement in Malaysia.—In his annual report on mining in the Federated Malay States, Mr. W. Eyre Kenny, Senior Warden of Mines, expresses regret that more cement is not manufactured locally, as excellent materials are available. This fact should be noted by those who are seeking an outlet for the employment of capital after the war, for with plenty of raw material within easy access, first-class transport facilities, relatively cheap labour, and a ready market throughout the Far East, it should not be a difficult matter to establish a profitable industry within a short space of time. The Batu Caves Cement Works, in Selangor, quarried 8,825 tons of limestone in 1915, and manufactured 5,725 tons of cement, all used locally, with the exception of 712 tons exported. The statistics of the Federated Malay States show that cement to the value of £40,000 was imported in 1915; but this was much below the average, owing to the restrictions imposed by war conditions on public works. In 1914 the value of imported cement into these States was £89,846, and in 1913 £91,674. A reference to the trade statistics of the Straits Settlements, however, gives a better idea of the requirements of this region, and from these it is found that the imports of cement were valued at £226,450 in 1912, £248,150 in 1913, £194,714 in 1914, and £210,253 in 1915.

Correction.—Mr. James Watt points out an error in the figures for the proportions of theine or caffeine in green tea, black tea, coffee, and maté, quoted on p. 701 of the *Journal* of August 25th. The figures, viz., 4·30, 4·60, 2·66, and 2·30 were given as parts in 1,000 on the authority of the report of the United States Consul at São Paulo, but they should have been given as percentages.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

FOTHERGILL LECTURES.

SURVEYING, PAST AND PRESENT.

By Edward A. Reeves, F.R.A.S., F.R.G.S.,
Map Curator and Instructor in Surveying to the Royal Geographical Society.

Lecture I.—Delivered March 27th, 1916.

HISTORICAL SKETCH.

When I was asked to come here and talk to you about surveying, I at first hesitated, chiefly because it seemed impossible to deal with the subject in a few lectures in a way that would be profitable or interesting. But upon further consideration I came to the conclusion that, after all, there were aspects of the subject which are not usually dealt with in text-books, and as my somewhat lengthy connection with the Royal Geographical Society has necessarily afforded me exceptional opportunities for coming into contact with travellers and geographical surveyors from many parts of the world, perhaps I ought to be in a position to say something not to be readily found elsewhere—so finally I decided to accept the honour of addressing you.

Surveying is a large subject, and one of which there are many branches. There is ordinary land surveying with the object of producing plans of property, or cadastral maps, for revenue purposes; railway and road surveying; mine surveying, and other departments of the subject which are generally limited to comparatively small areas, and are undertaken by the civil engineer in connection with some special work he has to carry out. But there is also geographical surveying, which has for its object the fixing of positions on the earth's surface, and the production of maps, often of previously little-known regions, giving a representation of the general geographical features.

It would be useless to attempt to deal with all of these in the space of three short lectures, and I therefore propose to restrict myself almost entirely to the latter with which I am more intimately connected, and to treat the subject in a general way without going at all into details.

In these three lectures I propose (1) to give a brief historical sketch of the way in which geographical surveying was done in early times, and the methods and instruments of the surveyors and explorers of those bygone days; then (2) to consider the present survey basis upon which maps of various parts of the world depend, the progress made in recent years, and the work remaining to be done; and finally (3) to give some account of present-day survey instruments and methods.

The acquirement of all knowledge has been progressive, sometimes moving slowly, at others more rapidly, but ever advancing; and this is specially true of the subject we have to consider. Our present knowledge of the earth's form, size, the configuration of its surface features, their measurement and representation on maps, is the result of many centuries of strenuous endeavour and conquest over obstacles, and at times over apparently insurmountable difficulties, the record of which constitutes a striking monument to indomitable courage and perseverance such as cannot be excelled in the history of mankind.

Of all branches of human research and discovery, that of geographical exploration and the measurement and representation, in some fashion, of the surface features of the earth is doubtless one of the oldest—in fact, it is difficult to imagine a time in the history of intelligent man when it did not in some manner exist, however rough and crude the attempts may have been.

The earth's surface is the present dwelling-place of man, and however high or far he may soar in imagination and thought, as to his bodily presence he is restricted to the surface of the comparatively small planet he inhabits. By his very nature he is an adventurer and a restless wanderer; and since his physical constitution does not permit of his travelling more than a very short distance vertically,

his only chance of expansion is horizontally or laterally, and geographical investigation and measurement was a natural consequence.

From the very earliest days there would arise the need of some sort of maps, and boundary questions, and limits of pasture lands and of irrigation rights would have to be settled; so that it is quite impossible to say when surveying commenced. From the rudest and most elementary beginnings it has, like all other departments of knowledge, slowly advanced as the centuries have passed and greater accuracy was required, until it has reached the refinement and exactitude which characterises it at the present day.

Probably the earliest attempts were those which naturally resulted from the necessity of representing in some sort of plan the limits of a man's private property, and an interesting example of this is the plan of an ancient Egyptian villa, evidently made from measurements, taken from a Theban tomb of the eighteenth dynasty, and given in Maspero's "Dawn of Civilisation." This must have been constructed more than 3,000 years ago, and is partly a plan and partly a perspective view. Another very old plan is that preserved at Turin, which represents the Wadi Alaiki, where the Nubian gold mines were situated, possibly dating back to about 1370 B.C.

A careful reader of the account of the dividing of the land of Canaan among the various tribes of Israel can hardly fail to come to the conclusion that Joshua had some sort of a map of the land before him when he proceeded to apportion the various districts, the boundaries of which are so minutely and carefully described; and it is also more than probable that he and the others who had been sent beforehand to spy out the land, as Gore says in his "Geodesy," "had in view quantity as well as quality," which implies some kind of rough survey and sketch map.

However this may have been, it is clear that at the period of their wandering in the wilderness the Israelites were familiar with measurement and planning; for the account given of the construction of the Tabernacle, with the details of its dimensions and the measurement of the land it was to occupy, with that of the surrounding encampment, is clear evidence that this was no new subject even at that time. How far this knowledge was obtained from the Egyptians or from some other source, and exactly what instruments and methods were employed, it would be interesting to learn.

At a later period we have the vision of "the man that had the measuring line in his hand," measuring out his thousands of cubits apparently much as a chainman does his work to-day.

So long as the district concerned was of no great extent, there could have been little difficulty about making a rough plan or map of it. For linear measurements of distance, the most natural units would be the lengths of various parts of the human body. The cubit, the pace, the foot, and the span were evidently amongst the earliest standards of all; and most of these have remained in use until to-day. With these, and an elementary knowledge of some of the simpler geometrical figures, it would be easy for quite useful plans to be constructed, as we know was the case. The longer distances were reckoned in time—the number of hours it took to travel between places, days' journeys, etc.; and later on in other measures such as the Greek stadium, of which it is generally understood there were 600 to a degree.

For comparatively short distances, when distinctive features were visible, there would be little difficulty in mapping roughly a route travelled, much as a man at the present day can make an approximate sketch to show any journey he has taken, without a compass or other instruments, or the Esquimo and other natives have drawn rough sketch maps to explain to explorers the direction any coastline follows.

A good example of this is the rough map of part of the west coast of Greenland, drawn by one of the Esquimos from his own knowledge and from that gathered from other natives on board H.M.S. "Assistance" during the winter of 1850–51; and a more recent example of the same kind of thing is a map of the tributaries of a river in Papua, sketched in the sand by a native chief for Mr. Beaver, who was exploring this region.

It is easy to understand that by following round coastlines, after repeated voyages, quite passable charts would be made by early navigators, as indeed we know was the case.

Long before the magnetic compass was known, at any rate in Europe, navigators and travellers had to find their way somehow, often through little-known regions; and when they had no landmarks to direct them they would have to seek some other means of guidance. Early nomad people of the desert would soon become acquainted with the heavenly bodies and their general movements and positions, and would naturally turn to these for the direction they sought. Their positions at certain seasons would, through being continually observed, become quite familiar, and so doubtless before

any instrumental astronomical observations were made men learned to march and steer their ships by the sun by day and the stars by night; and by such means routes would be roughly sketched on maps, and the tracks of vessels and coastlines of newly discovered lands laid down.

The heavenly bodies are the natural guides of the traveller, and the accuracy by which a path through the trackless desert can be found by natives accustomed to using them is often astonishing. Travellers in modern times have frequently borne testimony to this.

It is interesting to note that marching by stars is now receiving increased attention, and during the present war has proved invaluable to those who have taken the trouble to learn a little about it beforehand.

So long ago as the seventh century B.C., Thales, the Greek philosopher, had taught the Ionian sailors to use the stars and to steer by the Little Bear, as did the Phœnicians. According to Herodotus, the Phocæans were the first Greeks to undertake long voyages, and one of the most important exploring expeditions of ancient times was that of Pytheas, the discoverer of Britain in the fourth century B.C., who had not only learnt to sail by the stars, but to determine the latitude of points throughout the voyage by astronomical observations made with a gnomon or sort of sundial. The gnomon in its earliest form consisted of an upright rod, and was used for roughly determining time and the distance of any place from the equator, or the latitude. At the summer solstice, when the sun reached its greatest declination, at any place on the Tropic of Cancer the sun would be vertical at noon, and no shadow would be cast; hence the distance from the equator to the place where no shadow was cast was the same as the declination of the sun, or $23\frac{1}{2}°$ N. The distance to anyplace north or south of this position on the earth could then be computed from the length of the shadow cast by the gnomon. The invention of the gnomon is often ascribed to Anaximander, who was born in 612 B.C.; but it appears to have been in use among the Chaldeans long before this time, and probably all he did was to introduce it into Greece.

The gnomon used by Pytheas was doubtless of the simple form; but Aristarchus in the third century B.C. introduced a decided improvement in its design as an instrument for determining latitude, called the scaph, which deserves to be borne in mind by all surveyors, since it seems to have been the first instrument by which angles could be measured directly without computation. He substituted for the flat disc or plate a hemispherical bowl, in the centre of which an upright rod was fixed equal in length to the radius of the bowl. Concentric equidistant semicircles were drawn on the interior of the bowl, and these became a scale for the measurement of angles of altitude as indicated by the shadow of the rod or gnomon.

The voyage of Pytheas is of special importance, since it shows that even at that early date serious attempts were made at carrying out geographical surveys or exploring expeditions by sea on scientific lines. Sir Clements Markham gave an interesting paper on the voyage in Vol. I. of the *Geographical Journal*, which I would recommend anyone wishing to learn more of the subject to read.

In early days the earth was supposed to be divided into parallel zones within any of which the day was taken to be of the same length—one zone from twelve to thirteen hours, the next thirteen to fourteen hours and so on. These zones were called climates, from the Greek word "klima," a slope. From the comparative length of the day at any stated time of the year, such as the summer or winter solstice, the distance of the place north or south of the equator could be roughly computed. This was the usual method of determining latitude, and the one which Pytheas seems to have frequently followed; but in determining the latitude of Massilia (Marseilles) as a starting-point for his voyage he worked on improved lines. At the longest day, when the sun would be vertical at noon in the latitude of the Tropic of Cancer, and so no shadow would be cast on the dial, he found that the shadow of the gnomon measured $41\frac{4}{5}$ divisions of the 120 divisions which he had marked on the gnomon from which, by proportion, the altitude of the sun could be deduced as 70° 47′ 50″. When the semidiameter and the proper declination are applied this meridian altitude gives practically the true latitude of Marseilles, which is certainly remarkable, considering the roughness of the method, and must be more by chance than anything else.

Leaving Marseilles Pytheas sailed through the Straits of Gibraltar, round the coasts of Spain and Portugal, France, Belgium and Holland, thence up the east coasts of England and Scotland as far as the Orkney Islands. Latitude observations were taken at a number of places, and the expedition added a vast amount of new geographical information, and greatly improved the maps of the time.

The first record of anything that could be considered as geodetic surveying was the well-known attempt of Eratosthenes to ascertain the size of the earth by the measurement of an arc of the meridian. This wonderful old philosopher was born in Cyrene in 276 B.C., and was so noted for his learning that he was put in charge of the famous library of Alexandria.

The method he adopted was much the same in principle as that upon which geodesists work at the present time. Two places north and south of each other must necessarily be on the same great circle passing round the earth, and the task Eratosthenes set himself was to find the circumference of this great circle.

Supposing Alexandria and Syene (Assouan) to be exactly on the same meridian, he found that the difference of the angle cast by the shadow of the gnomon at midday at the two places at the time of the summer solstice was 7° 12′, and taking the linear distance between the two places to be 5,000 stadia, and multiplying this by 50, which was the proportion of the measured arc to the whole circle, he obtained 250,000 stadia as the circumference of the earth.

As there is a question as to the length of the stadium used by Eratosthenes, it is impossible to say what the degree of accuracy was; but if, as some have supposed, it was $\frac{1}{700}$ part of a degree, the circumference obtained would be only about 200 miles in error; but if, as is more likely, the ordinary Greek stadium was used, the error would be much greater. Apart from the rough method of measurement, there were many sources of error, one of which was that of assuming Alexandria and Syene to be exactly on the same meridian, so that no real accuracy was possible; but that at such an early date an attempt of the kind was made at all, and on lines similar in principle to those of the present time, is most remarkable.

This was the beginning of other attempts; and about 200 years later Posidonius undertook the solution of the problem by measuring an arc of the meridian between Rhodes and Alexandria, using the star Canopus instead of the sun, which ought to have given a better result; but as so few particulars are now obtainable, it is not possible to say with certainty how near to the true measure the result was.

The subject of the true figure and dimensions of the earth is a most important one in many respects, and greatly affects survey questions, since it must form the basis of all exact measurement on the earth's surface. Right on to the present day geodesists have been working at it, and although they have brought down the probable error in the measurements to what must be almost a minimum, yet even now the question is not finally settled.

As regards the maps of very early dates, it has always been a question as to how far they were the outcome of vague information collected by travellers without any attempt at instrumental measurement, and how far they were based upon some kind of route surveying and astronomical determinations.

At sea, as has been shown, occasional observations were made to determine the latitude, but the actual charting of the coastline, it is more than probable, was sketched in in the roughest possible manner, with little or no assistance from any kind of instruments.

After repeated voyages the navigators would naturally obtain a fair acquaintance with the general configuration of the coastlines with their bays and headlands, and be able to draw a fairly accurate chart. These rough sketches were sent from one to another and copied by hand by cartographers; so in course of time quite a fair representation was produced. It is indeed remarkable how good some of these old charts were.

As might be expected, now and then serious mistakes were made in the fitting together of various sections of charts received from different sources. This was probably due to the fact that in many cases they were rough copies from other copies of the originals, and with no proper means of settling the orientation the chart would be likely to be fitted on to another at quite a wrong angle. This is doubtless the explanation of some of the grosser errors in many of the old maps. For instance, in the early editions of Ptolemy (1472–1490), to the north of England there is a remarkable mass of land running something like east and west, and projecting a long way in the former direction. This is doubtless meant to be Scotland, but it is difficult to see how it could have got so wrongly drawn. Yet if we suppose the whole mass turned round at right angles, so that the part that projects to the east is placed to the north, we get a much better representation. There seems little doubt that somehow or other the whole thing has got wrongly joined on to England. In later editions this error has to a great extent been corrected.

Much of the same kind of thing frequently happens even at the present time, and one of the chief difficulties that a cartographer has to contend with is this question of orientation

A man makes a compass traverse of his route, or of some new river, which may be fairly accurate in itself, but through some mistake in his azimuth observation, or the compass variation, when it is fitted to existing work it gets turned round the wrong way.

A rough latitude could always be obtained from observation, but it was quite another thing with regard to longitude. Even at the present day there is far more uncertainty about a longitude observation than a latitude, and in early days, before the construction of accurate chronometers, to obtain the difference of longitude (or time) between two places accurately was a problem which could not be properly solved with the rough instruments and tables available, although the principle may have been understood. Consequently the longitudes on early maps were generally very wrong. The tendency was to sketch out the maps too far in an east and west direction, as the distances travelled were, as a rule, overestimated owing to the windings of the course and the unevenness of the ground not being properly allowed for. The same difficulty still holds good in all route traverses uncontrolled by fixed points, and almost invariably the distances given are too long. Still, it should always be remembered that but for the spreading out of the continent of Asia far too much to the east, Columbus might never have been led to suppose that he could reach the Indies by sailing west, and so not have undertaken his famous voyage across the Atlantic.

It has been a much disputed point as to whether Ptolemy's great geographical work, in its original form, had any maps at all. It was written somewhere about A.D. 150–160; but the first edition that we are acquainted with, with the maps, is of a date long subsequent, late in the thirteenth century A.D.

The original work contained long lists of latitudes and longitudes of places which have frequently led to the overestimating of the accuracy of their determination, and to the conclusion that quite a large amount of astronomical fixings and instrumental surveying had been done, even in the most out-of-the-way parts of the world, so long ago as that early date; but, in truth, there seems to have been nothing of the sort. Ptolemy collected what information he could at Alexandria from travellers in all parts of the world, and from the data thus obtained he drew maps which were no doubt far superior to others up to that time. It is then supposed that he drew latitude and longitude lines of a sort on maps, and afterwards made his tables of the positions of places from these, for ready reference and the use of other geographers.

Still, Ptolemy was fully alive to the importance of astronomical observations for the fixing of places, as (quoting from Nordenskiöld's Facsimile Atlas), he says in his geography (second chapter): "In the first place it is advisable to procure access to the journals of intelligent travellers who have visited distant countries. Their observations may be only of a geometrical character, *i.e.* only giving distances between different places, or they may be founded on observations made of celestial bodies by means of instruments for the measurement of the

FIG. 1.—ASTROLABE.

altitude of stars, and the length of the shadow of the gnomon. It is only with the aid of such instruments that the bearings and distances between different places can be determined."

The best known of all the old instruments is the astrolabe (Fig. 1), which is generally supposed to have been invented by Hipparchus about 150 B.C. Ptolemy and many others introduced modifications in it, some of which were doubtless improvements, while others, as is the case with many so-called improvements to surveying instruments of recent times, were of doubtful value, or merely unnecessary encumbrances.

In the hands of the Arab geographers specially the astrolabe became a most complicated affair, and contained much that was more concerned with astrology than astronomy. It remained in some form or other the principal instrument for astronomical observation and

determining of positions until the time of the great Portuguese navigations of the fifteenth century. The famous Portuguese "Junta," or committee appointed to consider the question of instruments and methods, very wisely decided to clear off all these unnecessary encumbrances, and finally produced an astrolabe much simpler in form and more generally suited for the work it had to do.

I have always admired the action of the Junta in clearing away the useless accretions that had gradually grown to the astrolabe and making it a more practical instrument, and often feel that it would not be a bad thing if some such committee could be found to deal in a similar way with modern instruments, for in the case of many of them there is much that rather tends to encumber than facilitate operations when put to a practical test. My experience has been that an instrument that is supposed to do many different things does nothing at all properly, and that the simpler a thing is the better.

Divested of all elaborations the astrolabe consisted of a somewhat heavy metal disc, varying in size from a few inches to over 2 ft. in diameter, suspended by a ring from the thumb, or, in the case of the larger instruments, hung on some sort of tripod arrangement. Pivoted at the centre was the movable sighting ruler or alidade, through the two ends of which the sun or stars were sighted; and the altitude was measured off on the graduated circle round the circumference of the disc. There was, of course, no vernier, and since the circle was only divided into degrees it was merely by estimation that readings closer than a degree could be obtained. There were on many of the astrolabes scales called the Umbra Recta and Umbra Versa, by means of which heights and distances of terrestrial objects could be approximately obtained.

These consisted of two scales, one at right angles to the other. The scales were divided into 100 equal parts. When the distance was known and the number of divisions on the vertical scale or Umbra Recta measured by the alidade, the height could be roughly computed by proportion. In the same way the distance could be found, when the height was known, by using the Umbra Versa, or horizontal scale. This was really a rough method of the trigonometrical computation of the present day, and when the angles subtended were not more than a few degrees, the fact that the divisions on the scales were all equal instead of being tangents would not introduce any very serious error.

Triangulation, as we understand it, that is the computation of the lengths of sides of triangles from a known base-line and measured angles, so far as is known did not come into use until the beginning of the seventeenth century, when Willebrord Snell, a mathematician of Amsterdam, carried out the computation of his arc of the meridian; but from the days of the Greek philosophers there seems to have been some sort of graphic triangulation in general use for land surveying; indeed, it would be difficult to believe otherwise when we remember the great advance that had been made in all matters connected with geometry. As to the instruments used for this very little definite information is available.

By some the diopter is supposed to have served some such purpose, but no one really seems to know now what this old instrument was like, although it probably resembled in its main features the diagrammatic sketch which is given in Laussedet's "Recherches sur les Instruments."

An interesting instrument, known in later times as Ptolemy's rods, was of very early date, certainly going back to the time of the famous Alexandrian geographer and astronomer, if not before; it deserves some attention, since it was used for obtaining the altitudes of heavenly bodies, and so the latitude. It consisted of three rods or rulers, one of which was held vertical, another directed towards the object whose zenith distance was to be measured, whilst the third gave the distance between the fixed points on the other two.

During the mediæval ages things were at a standstill, or rather went back, as regards all scientific pursuits, at any rate in Europe. This in a special manner affected geography and map-making. The advance that had been made by the Greeks was arrested, and the knowledge they had gained was lost sight of; so that instead of the maps being improved by more accurate surveys of explorers and travellers they were frequently drawn in monasteries by monks from imagination distorted by religious bigotry. The very idea of the spherical form of the earth was considered contrary to Scriptural teaching; Jerusalem was placed in the centre and other cities and countries at a distance and in positions assigned more at the will of the draughtsman than from any idea of geographical accuracy. The interiors of the least known parts, such as Africa, were filled by mythical monsters, and the whole became so crude and misleading that, instead of marking

any progress in geographical discovery, they are only interesting to the student as curiosities.

Map-making fared somewhat better in the hands of the Arabs, as will be seen from the Edrisi map of the world of 1154 A.D.; but many of their maps seem to have been made under the fixed impression that the outlines of all parts of the world must be formed by straight lines and arcs of circles drawn with a ruler and compass. An example of this is the Istakhri map of the world of 930 A.D. As time went on things began to improve, and some of the maps were quite creditable productions for the time.

It was not until the latter part of the fifteenth century, the time of the great Portuguese and Spanish discoveries, that there was any real advance, but then Europe seemed to awake out of a long sleep, and a grand new start was made.

It is no part of my plan in this lecture to attempt to describe the Portuguese voyages which resulted in the circumnavigation of Africa and the opening up of the sea route to India and the Far East, and I refer to them only in connection with the improvements that they called forth in the construction of instruments and methods of determining positions on the earth's surface.

One of the first acts of King John II. of Portugal (1481–1495), whose memory deserves to be equally held in respect with that of his great-uncle Prince Henry, was to bring together the "Junta," a committee of men noted for their learning in astronomy and navigation, to consider the best means of finding the latitude when the Pole Star got too low to be of service, and to decide upon the most suitable form of instrument for taking meridian altitudes. One of its members was the remarkable Martin Behaim, who is chiefly noted for his famous 1492 globe.

A learned Jew (converted to Christianity) named Abraham Zacuto, formerly professor of astronomy at Salamanca, came to Portugal about this time, bringing with him a work in Hebrew entitled "Almanac Perpetuum," which contained tables of the sun's declination required in the computation of the latitude. This almanac was translated into Latin by one Moses José, an eminent member of the Junta, and was published in Leiria in 1496. It perhaps deserves to be called the first "Nautical Almanac," and was of the greatest service on these early exploring voyages, since by its use far more accurate results could be obtained than was hitherto possible.

But equally important was the astrolabe, which has already been referred to. All the unnecessary elaborations were cleared away, and a simplified instrument much more suitable for the measure of altitudes was provided.

Equipped with the new tables and the improved astrolabe, the Portuguese navigators started on their famous voyages with a much better chance of accurately fixing positions of places than their predecessors.

The vernier had not yet been invented, and the difficulty of obtaining accurate readings of the circles was still considerable. To overcome this difficulty it was decided to construct astrolabes with very large circles, and the instrument carried by Vasco da Gama on his famous voyage round the Cape in 1497 was over 2 ft. in diameter. The size of the instrument certainly made it unwieldy and awkward to use, and it was found necessary to suspend it from some sort of stand, which meant that it could not have been used with much success on board ship. Vasco da Gama seems to have been fully alive to this, and so we find him, when he arrived at St. Helena Bay, not far from the Cape, bringing his instrument on shore. His observation and method of obtaining the latitude of this spot is of considerable interest. The sun's altitude measured 76° 20′, which gave a zenith distance of 13° 40′. He then turned to tables, and found that the sun was in 26° of the sign Scorpio, to which corresponded a declination of 19° 21′ S., so by adding this to the zenith distance he found the latitude, which he took to be 33° 0′ S.

I have recently tried to find out how near this result was to the truth, but it seems to be difficult to say exactly where the instrument was erected. If we take the head of the bay as the spot the error seems to be 13′, since this point as given on the latest Admiralty chart is 32° 47′ 0″ S. This error appears somewhat larger than might have been expected, but still, taking all things into consideration, it was not so bad after all. The possibilities of error from such instruments and methods are many, and it is an interesting question as to what sort of a result might reasonably be expected. To try and arrive at some conclusion as to this matter, on several occasions I have made altitude observations with rough home-made instruments of the astrolabe type, and have found that with care it is possible to get a latitude with an error of something like 5′ to 7′, taking the mean of several readings. With a circle divided only into degrees it is, of course, necessary to estimate

the subdivisions; but if several observations are taken in rapid succession it is possible to obtain a fair idea of the sun's meridian altitude, even with very rough instruments of the clinometer type.

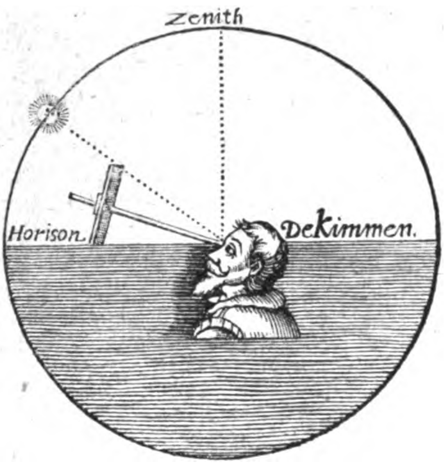

FIG. 2.—CROSS STAFF.

I have frequently heard surprise expressed at the accuracy of the results obtained by early navigators and explorers; but I feel sure that most of us, with a little practice, could have done what they did in this matter.

The old cross staff, shown in Fig. 2, was certainly an ingenious instrument, although the altitudes obtained with it must have been decidedly rough.

It consisted of two rods or pieces of wood at right angles to each other. The shorter piece had a hole in the centre, and was made to slide along the other. The eye was placed at the end of the long piece, and the sliding piece, or cross, was moved until one end of it cut the sea horizon and the other the sun. The degree of altitude was then read off on the longer rod, which was graduated and numbered. This appears to have been an instrument in common use by navigators in the sixteenth and seventeenth centuries, and even before that. The earliest known description of it is by Levi ben Gerson, a Babylonian Jew, in 1342 A.D., but whether he was really the inventor appears to be uncertain. Fig. 2, of the cross staff, is taken from Peter Goos' "Sea-Mirror" of 1658. The man using the instrument appears to be up to his eyes in water; but this is doubtless only an attempt to show the horizon line level with the eye—at any rate, we will hope that it was not really necessary to have a cold bath of this kind to use the instrument. It was not only for observing vertical angles that the cross staff was used, but for measuring horizontal and oblique angles as well.

The famous old British navigator and Arctic explorer, Captain John Davis, of the sixteenth century, constructed an instrument which was a decided improvement on the cross staff, which was used for years after and was known generally as the back staff. The great advantage of this instrument was that it enabled a man to take an altitude with his back to the sun instead of facing it. It certainly must have been no easy matter to have observed at all accurately with the sun shining in the face. Fig. 3 is a view of Davis's back staff, or quadrant, by which name it was also known. It consisted of a combination of two arcs, or a chord and an arc, upon each of which was a movable sight. The sight on the small arc was set to any convenient angle, say 30° or 60°, and then, with his back to the sun, the observer looked through the lower arc at the horizon line, at the same time adjusting the sight until he saw the sun's rays through the sight on the upper arc cutting the horizon line.

With such rough instruments all the early survey work was done. Captain John Davis, the daring old navigator who ventured far into the Arctic regions of America and discovered the Strait that still bears his name, deserves to be held in high esteem by geographical surveyors of all times; for not only did he improve the instruments of his day, but wrote a work, entitled "The Seaman's Secrets,"

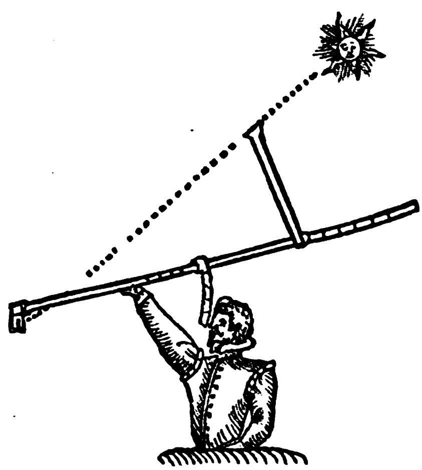

FIG. 3.—DAVIS BACK STAFF.

which was for a long time one of the principal guides to the subject of navigation and practical astronomy. He was also the first to introduce into this country the method of determining

longitude by lunar distances — a method that was most valuable before the perfecting of the chronometer, since it gave the Greenwich time. Captain J. Cook used it extensively on his surveys; and when the reflecting sextant came into use and better lunar tables were published, it was possible by this means to get a longitude at sea with greater accuracy than by any other. In fact, until quite recently it has been employed; but now, like all such methods, it has become obsolete, and for some years past the lunar distance tables, which used to form such a conspicuous part of the Nautical Almanac, have ceased to appear, although the method is still referred to, and directions given for working by it, if anyone wishes to do so.

The coming into general use of the magnetic compass not only made a wonderful difference to navigation and exploration by sea, by enabling the navigator to launch out boldly into the unknown with confidence, but soon began to leave its mark on land surveying and geographical exploration generally. Much has been written on the invention of the compass, and many have been the disputes on the subject; but it was certainly in use in the Mediterranean countries of Europe as early as the twelfth and thirteenth centuries. The date when it was first used for land surveying is not exactly known, but it was doubtless earlier than the sixteenth century.

FIG. 4.—PART OF SAXTON'S MAP OF SUSSEX, SURREY, AND KENT.

The magnetic compass in some form or another has perhaps done more for rough exploratory surveying than any other instrument; and is, of course, still extensively used when it is impossible to carry out a more accurate survey.

As regards land surveying, it was impossible to obtain anything approaching accuracy according to modern standards before the introduction of triangulation. Independent astronomical determinations are all very well, but cannot approach the accuracy of stations fixed by a regular triangulation, when the base-line and angles have been properly measured, and the whole work is carefully adjusted.

The early maps, even of our own country, were often very erroneous, and were based upon the measurement of distances along roads by some form of surveyor's perambulator, or by pacing. Many road-books appeared from the time of the "Itinerary" of John Leland, 1535-43, and all maps of the British Isles up to the date of the first Ordnance Survey at the end of the eighteenth century, were based almost entirely on itineraries and other rough surveying of private individuals. These were carried out with more or less care by the measurement of distances from place to place, and these distances were frequently given in tabular form or written on the maps. Sir George Fordham has devoted considerable attention to these early road maps, and has within the last few years published some interesting accounts of them.

The atlas of Christopher Saxton, published in 1577, during the reign of Queen Elizabeth, marked a great improvement in the maps of

England and Wales, and is generally taken to be the earliest collection of maps based upon regular surveys of some sort issued in this country. Fig. 4 shows a part of one of the maps from this atlas. As you see, it gives the South London district, with the counties of Kent, Surrey and Sussex.

Sometimes a man having a special knowledge of a certain locality or county would bring out a map as a private enterprise of his own, which would be a great improvement on any previously published. A good example of this is the map of Kent by Phil Symington which bears the date 1596. As regards accuracy, this map is much superior to others of the period, including that of Saxton. A comparison of the two would soon show this, and it is evident that it is based on fairly good surveys.

An idea of the sort of surveying carried on in this country in the early part of the seventeenth century may be obtained from the account given by Richard Norden of his attempt at measuring an arc of the meridian in 1633 between London and York. After describing how he took meridian altitudes of the sun with "a sextant of more than 5 ft. semidiameter," he goes on to state how he made the linear measurements of the distance between the two places. He says: "I measured (for the most part) the way from thence (York) to London, and where I measured not I paced (wherein through custom I usually come very near the truth), observing all the way as I came with a circumferator all the principal angles of position or windings of the way, with convenient allowance for other lesser windings, ascents and descents, so that I may affirm the experiment to be near the truth." I do not know what our present geodesists would think of obtaining the distance between two points for the measuring of an arc of the meridian by pacing. This piece of work was carried out by Norden eighteen years after Snell had shown the correct way of doing it by triangulation; so it was rather a retrograde step.

There are some interesting remarks in the preface to Ogilby's "Britannia" of 1675, on the surveys upon which the maps in that work were based, which also incidentally show that rivalry between surveyors and map-makers existed in that day as well as this. The wording is so quaint that I think it may be worth while to quote some part of it here. After stating that the maps were from "actual dimensuration," he goes on to say that the maps of "Bleau, Sanson, and the rest, so eminent for the curious performances of the graver" were even the most accurate of them; "but so many guess plans and their perambulated projections, as those of our own country compiled by Mr. Saxton, and more and more vitiated since by transcribers and copiers, much inferior to what might have been done by a strict dimensuration . . . We may adjoyn a word or two of dimensurators or measuring instruments, whereof the most usual has been the chain, and the common length for English measure, 4 poles, as answering indifferently to the English mile and acre. We have been facilitated, therefore, in this great work by the Wheel Dimensurator, which for ease and accurateness infinitely surpasses the chain, as being manageable by a single person, measuring even the smallest deviation of the way, and finishing a revolution but once in ten miles. We . . . commend rather the foot-wheel here mentioned, of half a pole circumference with the Way-Wizars as they are now regulated, than any such like coach or chariot measurer whatever." (Ogilby's "Britannia," Vol. I., preface, 1675.)

The "Wheel Dimensurator" was much the same as the ordinary survey perambulator, which measures the number of revolutions on a dial.

Triangulation holds such an important place in all accurate surveying, since it furnishes the control points to which the topographical details can be adjusted, that a brief notice of the first recorded occasion of its being employed will doubtless be of interest.

It is supposed that Ptolemy was fully alive to the fact that it was not necessary actually to measure the whole length of an arc of the meridian, but that some parts could be computed, or perhaps graphically obtained, much as is now done in plane-tabling; but so far as we know, the first to introduce triangulation from a measured base and angles was Willebrord Snell (or Snellius) of the Netherlands, who lived in the early part of the seventeenth century, and to whom I have already incidentally referred.

The work he undertook was in connection with the measurement of an arc of the meridian. Up to his time the distances between the two ends of the line had been obtained by direct measurement of a doubtful value as regards accuracy.

In order to obtain a better result, Snell decided to measure a short line as a base and obtain the total length by the measurement of angles and computation, which must have been a most laborious undertaking since he had no tables of logarithms to work with. The

instrument used for the measurement of the angles was a graduated semicircle of 3½ ft. diameter. The vernier was not invented till about sixteen years later, so the angle readings

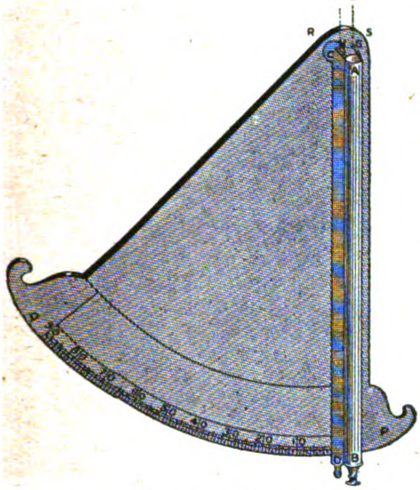

FIG. 5.—NEWTON'S OCTANT.

were necessarily very rough, but it was thought that having such a large circle would add considerably to the accuracy.

The length of the arc was about eighty-five miles, and extended from Alcmaar to Bergen-op-Zoom. A base-line was first measured with a chain 326·4 Rheinish rods in length (a little over three-quarters of a mile), and then, with

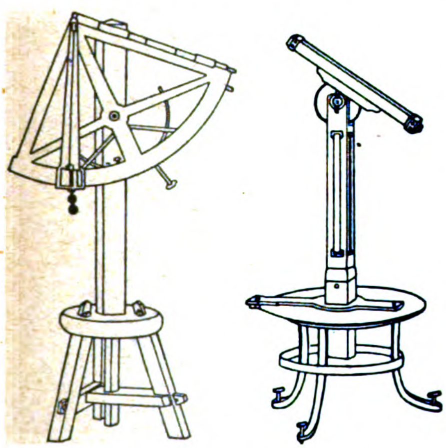

FIG. 6.—INŌ CHŪKEI'S INSTRUMENTS.

this line known and the angles measured, the sides were computed, and upon these sides other triangles built up. Altogether thirty-three triangles were constructed and computed between the terminal points of the chain. This process is practically the same as that now employed in extending a triangulation, and the debt of gratitude due to Willebrord Snell is very great indeed. Like all things of the kind, it seems easy enough, and only natural when once the way is shown, and it is remarkable that it was not thought of before.

The result obtained by Snell was not so accurate as might have been thought likely; but there were many sources of error, some of which he was fully aware of, and so he attempted to repeat the whole of the work, but never lived to finish it. The error in the length of a degree was about 12,789 ft., which is large, since the

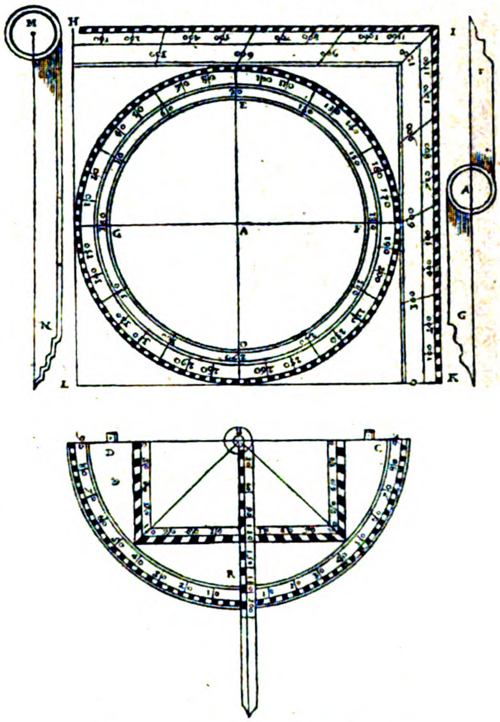

FIG. 7.—DIGGES' THEODOLITE.

method employed was correct, and was doubtless due to a combination of several causes, some instrumental and others in the computation.

Musschenbrock, a descendant of Snell, undertook the revision of the work about one hundred years later, and with a telescope attached to the quadrant used, and new determinations of the latitudes of the terminal points, he obtained a length for the arc very much nearer the truth.

The introduction of triangulation laid the foundation for all accurate surveying since Snell's time. Much has been done by way of improvement, but the great Survey of India, the Ordnance Survey of this country, and the

trigonometrical surveys on the Continent and in America, have all been conducted on the basis of the system which he was the first to introduce.

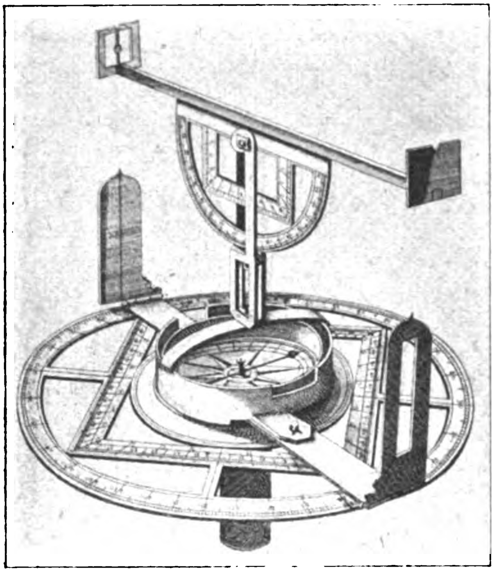

FIG. 8.—OLD THEODOLITE (Bleau's Atlas).

From this time great and rapid advance was made in surveying instruments which tended to increased accuracy, such as the improvement in chronometers, the invention of the reflecting quadrant and sextant, which, though attributed to Hadley, was really first proposed by Sir Isaac Newton. Fig. 5 shows Newton's design for a reflecting octant.

The invention of the nonius by Peter Nunez, in the middle of the sixteenth century, marked a step forward in the means of accurate reading of the circle divisions ; but with the introduction of the vernier in 1630, by Francis Vernier, the nonius rapidly became obsolete, as the simple and extremely ingenious invention of the Frenchman very soon took its place, as indeed it deserved.

We are apt to imagine that it was only Europeans who made any advance in the art of geographical surveying in these early times, but although this may be true to a great extent, there have been one or two brilliant exceptions. A very remarkable one was that of a Japanese named Inō Chūkei, who, with instruments designed and constructed by himself, carried out a survey and mapped the greater part of Japan by his own individual enterprise.

Inō Chūkei was born in 1744, and until 1795 was a brewer of saké, but in his spare time studied astronomy and became quite a good astronomer. When he was fifty-five years of age he petitioned the government to be allowed to make a survey of his country at his own expense. At that time no accurate maps existed, the only ones that were any good at all being those made by the Jesuit missionaries, which were very rough and erroneous.

Fig. 6 is a sketch of Inō Chūkei's instruments. These consisted of a brass quadrant, an azimuth instrument or sort of theodolite for giving vertical angles, and a compass. The quadrant was for observing altitudes, and the arc had a radius of 19 in. It was mounted on a wooden stand, with a telescope fixed to one of the straight sides. By means of a diagonal scale readings to 1′ of arc could be obtained with the plumb-line.

The azimuth instrument had a horizontal circular disc of copper, 19 in. in diameter, graduated to degrees, and by means of a diagonal scale could be read to 10′. Passing through the disc, or horizontal circle, was an upright wooden pillar carrying a telescope, and a flat horizontal arm. The pillar, telescope and arm rotated together, and when the distant point was sighted in the telescope the indicator on the arm gave the horizontal angles.

These instruments, or rather reproductions of them, were on view at the Japan-British Exhibition in London some years ago. The survey made by Inō Chūkei was certainly very good, considering all the circumstances. When compared with the modern correct values, many of the observed latitudes were found to be less

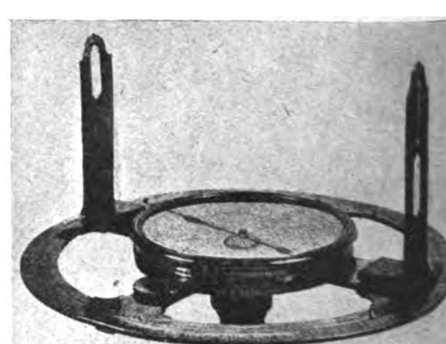

FIG. 9.—THE COMMON THEODOLITE.

than 1′ in error, while the error in the difference of longitude between places seems to range from 0′ to 6′ as compared with recent values.

Altogether Chūkei surveyed about 137,000

square miles, 16,000 square miles more than the area of the British Isles.

When we take everything into consideration, I think we must agree with Mr. E. B. Knobel,

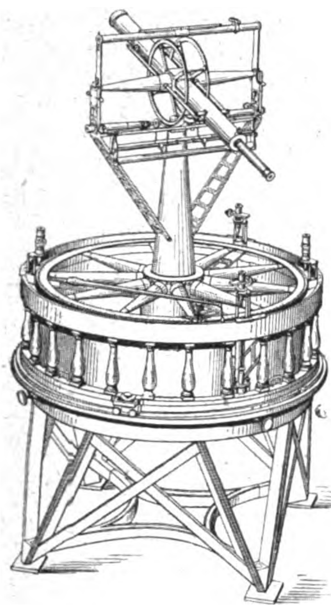

FIG. 10.—RAMSDEN'S THEODOLITE.

who gave an interesting account of Chūkei's surveys in the *Geographical Journal* for September, 1913, that "it is pathetic to read that he met with no reward in his lifetime, for on the termination of his work he was thrown into prison by the Shōguns, where he remained until his death in the year 1821." However, when more enlightened days dawned upon Japan, his works were published, in 1870, and an Imperial Order was conferred on the man long since dead, and a monument erected to his memory in the Shiba temple at Tokyo.

Of all the instruments used by the surveyor there is doubtless none more important than the theodolite, and I propose to close this lecture by giving some idea of the development of this instrument.

Fig. 7 shows the theodolite of Leonard Digges, who seems to have been the real inventor, and whose invention was described by him in his book on surveying, which was completed by his son, and published in 1571. As you see, the vertical and horizontal arcs are here separately shown; but it is clear that the former is intended to be inserted in a vertical position in the centre of the latter.

Fig. 8 shows a theodolite much of the same form, taken from Bleau's famous old seventeenth-century Dutch atlas.

Fig. 9 is a photograph of the "common theodolite," as it was called, since it had no telescope, carried by Messrs. Mason and Dixon to the United States, and used by them during the survey of the boundary between Maryland and Pennsylvania, which was commenced in 1763. It was made by Adams, of London, and was evidently only intended for observing horizontal angles. In many respects it resembles what is generally known as a circumferator rather than a theodolite. The instrument itself is now in the museum of the Royal Geographical Society, and was described in the *Geographical Journal* for January last.

We may, I think, be proud of the fact that the theodolite is really an English instrument, both in its origin and principal improvements.

Fig. 10 shows the famous Ramsden theodolite, which was used on the triangulation of England in 1787, when it was decided to connect the triangulation of France with that of this country. In 1763 Ramsden had invented a graduating machine for dividing the circles, and soon after

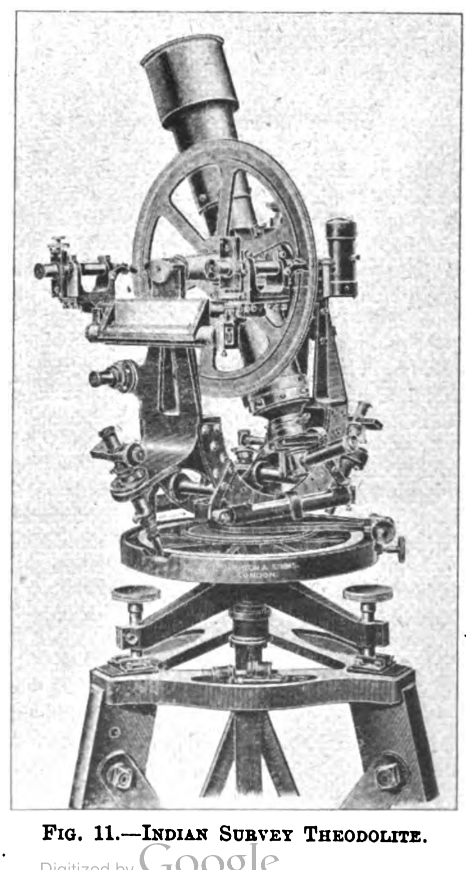

FIG. 11.—INDIAN SURVEY THEODOLITE.

commenced the construction of the excellent instrument. After being used on the triangulation of this country for many years, and having done good service in India, it has found a permanent resting-place at the Ordnance Survey Office. It was constructed with a horizontal circle of 3 ft. diameter, and by means of micrometers could be read to single seconds. By way of completing the series, I show (Fig. 11) finally a micrometer theodolite used by the Survey of India.

ENGINEERING NOTES.

Irrigation, etc., in the Crimea.—The Russian Supplement of the *Times* describes the rich valleys of the Crimea which are receiving great attention from the Russian Government. In 1913 there was established at Simferopol an office for the survey of water sources. Here an able staff of engineers has collected a vast amount of water statistics and other information, erected meteorological stations, measured the flow of all the rivers mentioned, and prepared large irrigation projects. For example, in the Salgir Valley one such has been drafted involving an expenditure of £300,000, which will give Simferopol a new water supply and convert 1,859 square miles into valuable apple or tobacco land. Such irrigated land is valued at from £110 to £150 per acre, and the land alone would be worth some £1,500,000. These engineers are also making great preparations for sanatoria all along the coast from Otusi to Sevastopol and at the Saki mud baths, where artesian wells have been sunk by them. The increase of visitors is so great as to justify this, and it is no exaggeration to say that the Crimea is rapidly becoming a very popular resort. As to the irrigation schemes, it is hoped to increase the area from 50 square versts to 500 square versts, when the Crimea will offer to the fruit planter attractions equal to those of Cripple Creek, California, or the Australasian apple lands, for the Crimea has unlimited markets near at hand for her fruit products, and even now supplies Russia with her choicest apples and pears from the Apple Valleys, with rich wines and grapes from the Vine Valleys, as well as other fruit and nuts, not forgetting tobacco. The Russian Minister concerned with the great work proceeding has just paid a visit of inspection, and is well satisfied with what has been done.

The Reversing Falls, St. John, New Brunswick.—The proposal in the *Electrical Review* to harness the tides of the Bay of Fundy, at Cape Split, Nova Scotia, by means of a current motor, which would pump the water into huge reservoirs on the cliff above, the descending water furnishing the power, has been followed by a suggestion to utilise the Reversing Falls at St. John, New Brunswick, in a like manner. The suggestion has come from the acting Resident Engineer of the Department of Public Works, who says that a stronger current is available at the Falls than at Cape Split, and there would be a longer period between tides for a motor-pump to operate. All attempts to utilise their tremendous energy have, so far, failed, but by the application of a current such as has been suggested at Cape Split, and by the erection of reservoirs on the height above, it is thought that, at last, a way has been found by which the Falls may be harnessed.

The Folla Scheme in Norway.—A scheme has been prepared for the utilisation of 50,000 h.p. through the exploitation of the Folla in Norway. This stream comes from the Troldheimen Mountains, and after a course of about twenty-five miles joins the Surna, which terminates in the Surendal Fjord. The Folla has no natural regulating basin, not passing through any lake of a size to serve as a reservoir, though it has abundance of water, the catchment area being 347 square kilometres. A valley, which is of no special value to anyone, is therefore being flooded to create a lake, having an area of 8 square kilometres, by building a wall 30·5 metres high and 648 metres long. There will be a fall of 300 metres, and at the turbines the power will be 40,000 to 50,000 h.p. In addition there are two other falls in the Folla. below the regulating dam, of respectively 7,200 and 10,000 h.p. The large power-station will be situated at the bottom of the Fol Valley; a tunnel over two miles long and 12 square metres section, will lead from the intake to the distribution basin. The energy will be transmitted over eight miles to Surendalsören, in the vicinity of which the promoter of the scheme controls large lime deposits, which can supply necessary raw material. The manufacture is likely to comprise carbide and cyanamide, an annual production of 25,000 to 30,000 tons being expected. The aggregate cost is calculated at nearly £800,000, of which nearly £350,000 is allocated to the power-station, etc., and nearly £75,000 to the electrical plant. The *Times* is our authority for these details.

The New Welland Ship Canal.—This connects the lakes Erie and Ontario and is the greatest engineering work at present under construction in Canada. When completed the canal will accommodate vessels up to 800 ft. long, and with a draught of 25 ft. It will be twenty-five miles long, and will have seven locks, each with a lift of 46 ft. 6 in. The work on the canal was commenced in 1913, and the complete work will probably take six years, the approximate cost being £10,500,000. The canal will form the third connecting link between these two lakes

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PROCEEDINGS OF THE SOCIETY.

FOTHERGILL LECTURES.

SURVEYING, PAST AND PRESENT.

By EDWARD A. REEVES, F.R.A.S., F.R.G.S.,
Map Curator and Instructor in Surveying to the Royal Geographical Society.

Lecture II.—Delivered April 3rd, 1916.

PRESENT POSITION OF SURVEYING AND MAPPING OF THE WORLD.

In my last lecture I described briefly some of the earliest attempts at surveying, and the instruments and methods by which these surveys were carried out; and I will now try to give you an idea of what has so far been accomplished toward the mapping of the earth's features, and the present position of various parts of the world as regards the surveys upon which the maps depend. In doing this I shall also endeavour to describe briefly, and show examples of, the work that has been done during the past fifty or sixty years, as well as give some indication of what remains to be accomplished by future explorers and geographical surveyors.

All human progress and endeavour that has achieved any success has been the result of hard struggles and long perseverance against many difficulties, and this is specially the case with regard to the subject with which we are dealing. Little by little civilised man, by his daring, his love of adventure, and the necessities of events and circumstances, has penetrated into the unexplored parts of the earth, and pushed back the clouds and mists that so long shrouded it from his knowledge, until at the present time the regions that are entirely unknown are very few indeed, and do not amount to more than one-seventh part of the whole land surface of the globe, including the unexplored areas of the Polar regions which may be either land or water. Not content with a mere vague acquaintance, he has striven for greater accuracy, and has turned to various branches of science and called them to his aid in order that he may obtain more correct knowledge, and a better comprehension of the earth's features. To enable him to fix with definiteness the position of places, map out the various land forms, and obtain their accurate measurements, he has consulted the astronomer and mathematician.

Commencing with modest instruments and measuring apparatus, these, as greater accuracy was required, have gradually been improved until the present-day appliances and equipment of the surveyor are wonders of refinement and delicacy, in the construction of which the greatest ingenuity of mechanical skill has been called forth. But the work has been gradual; not only the progress of geographical surveying itself, but as regards the appliances for accomplishing it; and the two are so interwoven and connected that it is impossible to describe the one without dealing to some extent with the other, so that it will be necessary for me to combine them in what I shall bring before you.

To begin with, it is important that we should have a general idea of what parts of the world have been surveyed and what have not, as well as ascertain something of the relative value of the survey basis for maps of the various parts of the world at the present time; and so I propose to show a map of the world I have recently drawn. It is merely an outline and diagrammatic in character, but, I trust, will help to make the matter clear. By way of comparison I have drawn another map showing what was surveyed at all accurately, mapped from rough surveys, and entirely unsurveyed and unmapped in 1860—that is, nearly sixty years ago. These maps will, I hope, convey more to you than if I placed before you mere tables of figures and statistics, which, though important in their place, do not give at a glance the facts and proportions that can be furnished by maps and diagrams.

The maps are both drawn on an equal-area projection—that is to say, a certain area on the map, such as a square inch, everywhere represents the same number of square miles on the earth's surface.

1860.

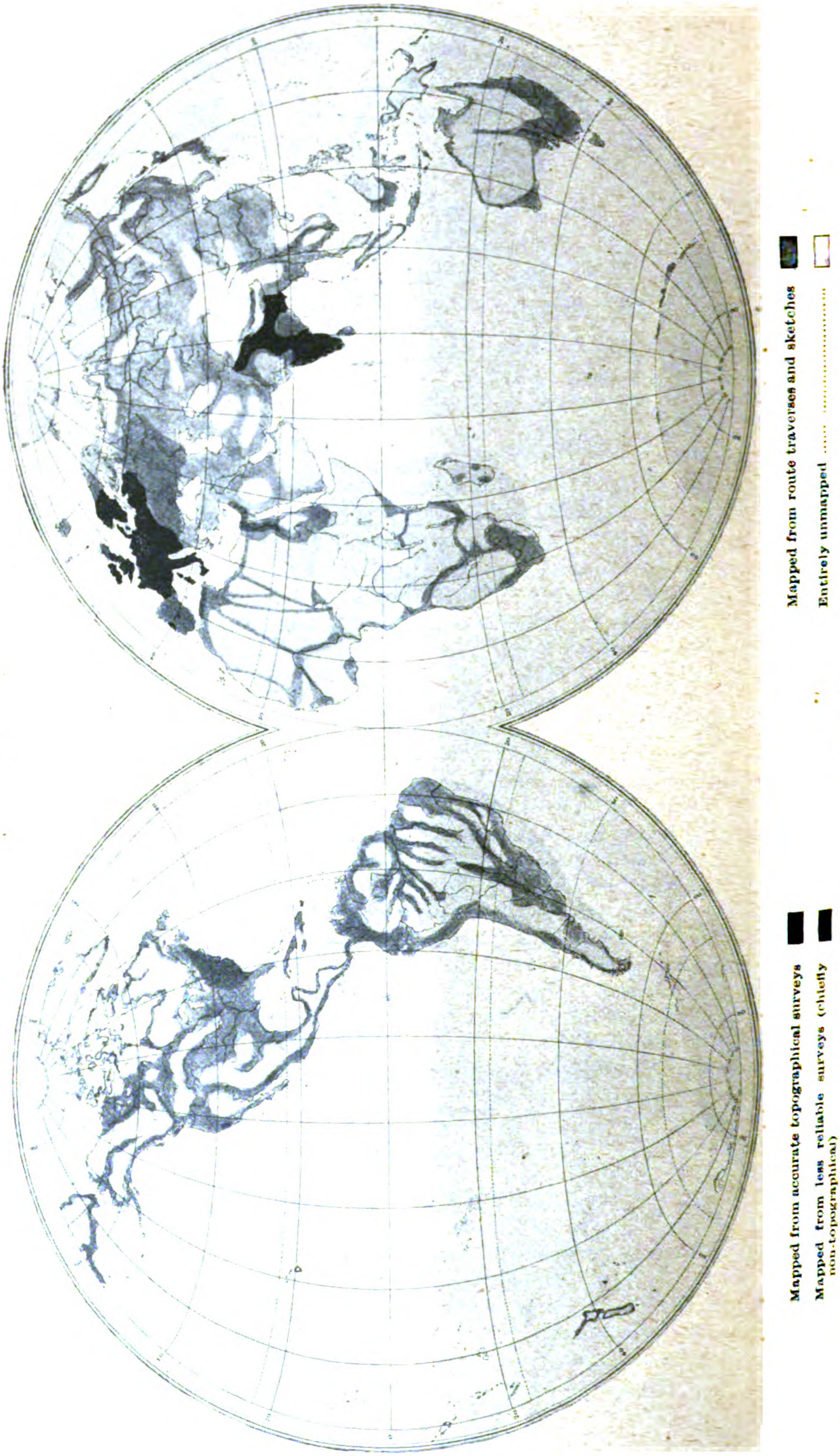

Mapped from accurate topographical surveys
Mapped from less reliable surveys (chiefly non-topographical)
Mapped from route traverses and sketches
Entirely unmapped

Fig. 12.

1916.

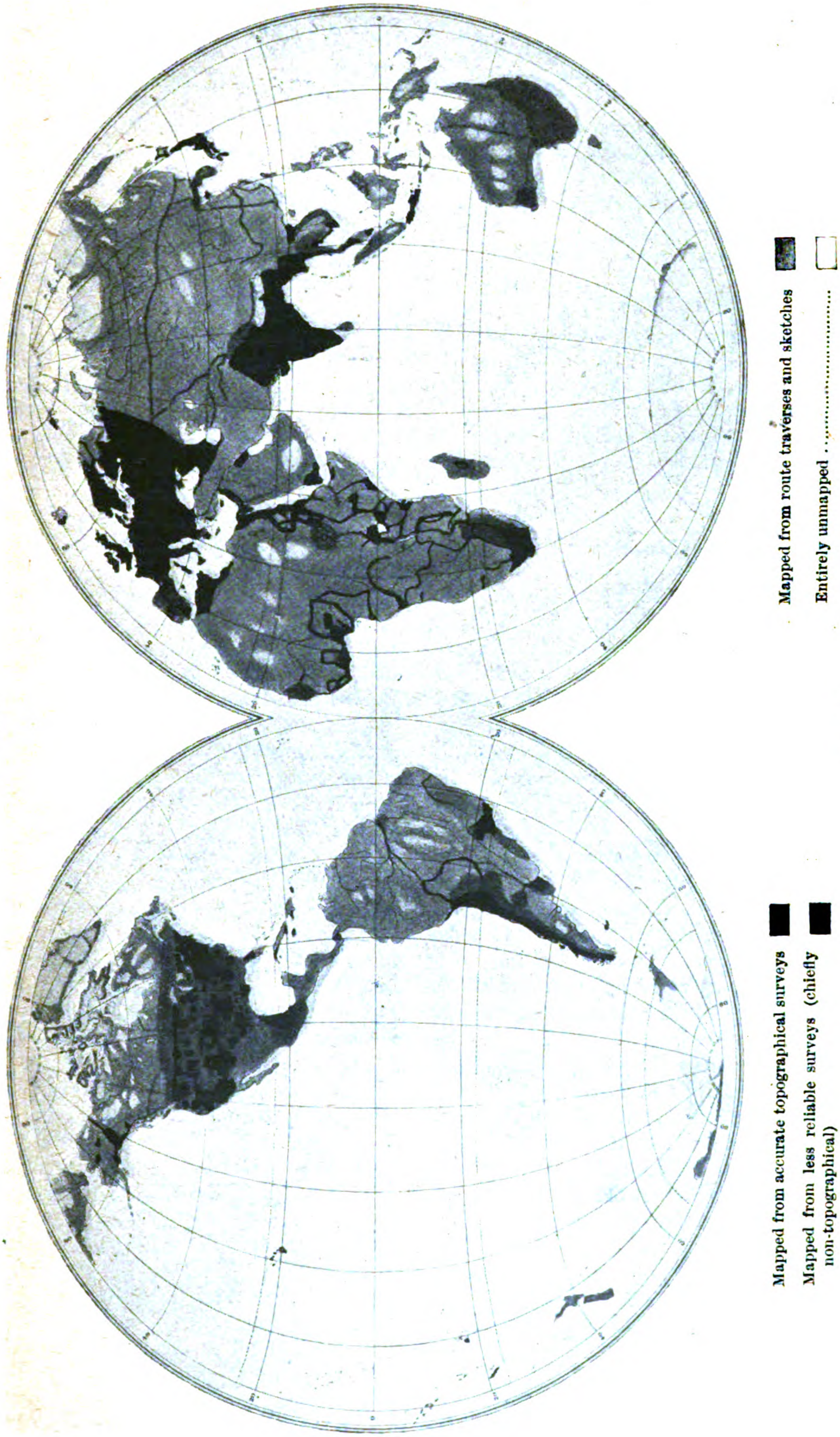

Mapped from accurate topographical surveys
Mapped from less reliable surveys (chiefly non-topographical)
Mapped from route traverses and sketches
Entirely unmapped ....

FIG. 13.

The idea kept in mind in drawing the maps is that the shade deepens as the accuracy of the surveys increases: (1) The parts topographically mapped from triangulation or rigorous traverses are shown by the darkest tint; (2) those less accurately mapped from surveys chiefly non-topographical, and of which in many places the basis consists to a great extent of disconnected land-office and property plans, are shown by the tint next in density; and then the third (3) tint represents the parts of the world only mapped from route surveys or traverses of explorers. Although these traverses vary greatly in degree of accuracy, they cannot be considered so reliable as the surveys shown by either of the other two shades; and in many instances the mapping consists of the roughest sketches; (4) the regions entirely unsurveyed and unmapped are indicated by the lightest tint of all—almost white.

Before dealing with the present-day map, which we shall consider somewhat fully, I desire to call attention to the 1860 map.

The first map (Fig. 12) shows the state of surveys in the Eastern Hemisphere in 1860, and it will be seen at once that outside the continent of Europe, where a considerable extent of accurate surveying had been done, the only country where there was any mapping based upon triangulation was India. These areas are shown in the darkest shading. In Europe the British Isles, France, Germany, Austria, Italy, Russia, Switzerland, Denmark, the Netherlands and Scandinavia had already made a good commencement with their government surveys, but these were in several cases by no means complete; and it is interesting to note that even of Scotland there existed at that time no Ordnance Survey of its northern part. The southern part had been surveyed and mapped on the 1-inch scale long before this date, but the survey was afterwards carried on in England, and on the 6-inch scale in Ireland, so that the northern part of Scotland was not done in 1860.

India has been noted for the excellence of its surveys ever since the days of Major Lambton, who started the work in 1804, and Colonel Everest, who succeeded him as head of the Government surveys after his death in 1823. As will be seen by the map, in 1860 a considerable extent of India had been mapped from trigonometrical surveys. Even before Lambton's time India had been well ahead with its surveys of any other country outside Europe, which was entirely due to the energy and skill of Major James Rennell, who, as Surveyor-General of Bengal, surveyed the Ganges and lower Brahmaputra Rivers, as well as the districts of Bengal and Behar, between 1763 and 1782.

In the parts of the Eastern Hemisphere that were surveyed and mapped in the second degree of accuracy, according to our system—that is, those shown by the next tint—may be included most of the remaining parts of Europe, Egypt, and parts of Algeria near the coast. For the rest, such mapping as was done was based upon rough route sketches, as shown by the third tint. In this must be included practically all other known parts of the African continent, such as those explored by Mungo Park, Beke, Livingstone, Speke and Grant, and others; as must also be the early exploratory surveys in Central Asia and Australia.

The regions that were entirely unsurveyed and unmapped at this time were, as will be seen, enormous in their extent, and included not only those in the neighbourhood of the Poles, but vast areas of Central Asia, Africa and Australia.

Turning to the Western Hemisphere, we find that at this date, 1860, no triangulation of any extent had been carried out. The United States Coast and Geodetic Survey had made a good start, but their work had been confined to the coastline or districts near the coast. There had been La Condamine's attempt at measuring an arc of the meridian near Quito in South America in 1736, the measurement of the Mason and Dixon line, and their survey of the boundary between Pennsylvania and Maryland in the latter part of the same century; but neither of these resulted in any serious topographical mapping. Such surveys as existed of the interior parts of the United States in 1860, although they varied considerably as regards their merits and degree of dependence, could not be considered as anything but approximate.

Some parts of the Eastern States are shaded with a tint of the second density, but apart from this, such mapping as had been done either in North or South America cannot be considered of a higher order than route traversing and rough sketching, and is tinted accordingly.

Vast areas of Central Asia, and a still larger portion of the interior of Africa were entirely unmapped in 1860, as was also the case with South America away from the courses of the great rivers, vast areas of North America, and the Arctic regions.

Attempts had been made to penetrate and traverse the desert-like interior of Australia, but to a great extent this region still remained entirely unmapped.

Several important expeditions had commenced the exploration and mapping of the coastline of the Antarctic continent, such as that of Captain James Clarke Ross, which had penetrated a considerable distance south in the neighbourhood of South Victoria Land, and Captain Wilkes and others who sighted land to the west of this region; but, after all, little had been done in the way of surveying and mapping in the Antarctic regions.

Referring now to the present-day map (Fig. 13) on which the same shades of tinting have the same meaning as on the previous map, you will see at once that the parts that are accurately surveyed from a topographical point of view, based on triangulation or rigorous traverses, have greatly increased in extent, and these now represent, according to a rough estimate I have made, about one-seventh of the total area of the land surface of the earth, instead of only one-thirtieth, as was the case in 1860. Remarkable progress has also been made with regard to both of the less accurate classes of surveying and mapping, while the parts that are entirely unsurveyed and unmapped only amount to about one-seventh instead of a little over half, which was roughly the extent fifty-six years ago.

I have attempted to form an estimate of the condition of the world's surveys as represented by the differently tinted areas on the maps for 1860 and 1916; and, taking the total area of the land surface of the earth, together with the unknown parts of the Arctic and Antarctic regions which may be either land or water, to be 60,000,000 square miles, I have obtained the following results:—

It may be interesting to see these proportions in diagrammatic form (Fig. 14), which gives the general results perhaps more clearly than in any other manner.

From the figures given it is plain that, with the same rate of progress as that of the past fifty-six years, it would take just over 400 years more to complete the accurate surveying and topographical mapping of the earth's land

1860. 1916.

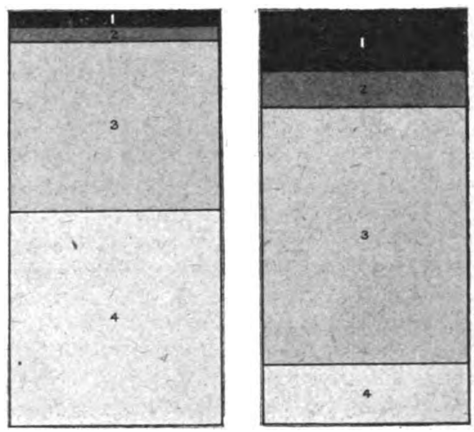


FIG. 14.

surface, including the parts of the Polar regions that may possibly be land, that is the 60,000,000 square miles which we have taken for this total area: but this will certainly not be the case, since the rate at which such surveys have been carried out has been greatly accelerated during recent years, owing to the rapidly increasing demands for accurate maps, improvements in methods ane other causes; so that it will

	1860.		1916.	
	Square Statute Miles.	Proportion to Whole.	Square Statute Miles.	Proportion to Whole.
1. Mapped from accurate topographical surveys, based on triangulation or rigorous traverses.	1,957,755	0·0326 or roughly $\frac{1}{30}$.	8,897,238	0·1482 or roughly $\frac{1}{7}$.
2. Mapped from less reliable surveys, chiefly non-topographical.	2,017,641	0·0336 or roughly $\frac{1}{30}$.	5,178,008	0·0866 or just over $\frac{1}{12}$.
3. Mapped from route traverses and sketches.	25,024,360	0·4170 or roughly $\frac{2}{5}$.	37,550,552	0·6258 or little less than $\frac{2}{3}$.
4. Entirely unsurveyed and unmapped.	30,997,054	0·5166 or just over $\frac{1}{2}$.	8,350,794	0·1391 or little less than $\frac{1}{7}$.

probably not be half this time before all the parts of the earth's surface that are likely to be of any use to man as settlements, or are capable of being developed, are properly surveyed and mapped. There are, of course, regions such as those near the Poles and in arid deserts that are never likely to be accurately triangulated and mapped, and it would be merely a waste of time and money to attempt anything of the kind.

The surveying and mapping of the surface of the earth, so far as it has been accomplished, has called forth all the spirit of adventure in the pioneer, who has penetrated the vast unexplored regions through tropical forests, scorching sands and fields of polar ice and snow, despising all risks, that he may bring back a knowledge of the regions he has visited, and a representation in the form of the best map he was able to make of the geographical features of the country; while for the trained surveyor, who follows the pioneer explorer with his theodolite and other instruments of precision, it has meant long journeys and sojourns, often under enormous difficulties, in all sorts of climates and adverse conditions.

As might be expected, the parts of the earth's land surface that are accurately surveyed, about one-seventh of the whole, are those inhabited by the most civilised nations and their dominions. The areas so mapped include the European countries, with the exception of some parts of the Balkan States, India, Japan, Algeria, Tunis, Egypt, and other parts of Africa under the domination of European nations or inhabited by Europeans, the United States, parts of Canada and Mexico, the international boundaries between some of the Asiatic, African and South American countries, and very restricted areas of Australasia. These are all shown by the darkest tint on the map.

The parts that are still unsurveyed in any sense are, as has been seen, certain remote unexplored regions near the Poles, a few patches in Central Asia, much of the interior of Arabia, parts of the Sahara and some other areas in Central Africa, parts of the interior of South America, specially those between the great rivers, and certain areas of the interior of Australia. These are shown by the lightest shade on the map, and at the present day represent slightly less than the area that is accurately mapped. Between these two extremes the surveying and mapping varies in merit and degree of reliability from that of a fairly accurate nature (such as land-office plans, which make little pretence at showing topographical features), which may be taken as covering about one-twelfth of the earth's land area, and that enormously extensive area only roughly mapped from route traverses of explorers and others, which now constitutes about two-thirds of the whole of the earth's land surface.

These different kinds of surveys, and the methods by which they have been carried out, will be dealt with specially in the next lecture, although that with which I am mostly concerned is perhaps the last, since it is one of my duties at the Royal Geographical Society to instruct travellers in geographical surveying.

Ordinary land surveying, such as undertaken by civil engineers, does not immediately concern us at the Geographical Society, since its function is for the most part to produce large-scale plans for engineering and other special purposes, usually of very small areas, and it does not yield much topographical or geographical result.

Trigonometrical surveying forms the basis of all accurate mapping, so this comes within our province, in so far as it constitutes the framework and points of control for topographical mapping.

Many and varied have been the influences that have led to the surveys that have already been carried out, and it would be interesting if we could analyse them; but there is only time now to refer briefly to some of the more important.

Among the preliminary reconnaisance surveys it would, I think, be found that military operations hold an important place. Many an unexplored region has been mapped for the first time as the result of frontier expeditions, such as those on the transfrontier regions of India, like the expedition to Tibet of 1904, during which most important mapping work was done from Sikkim to Lhasa, and west along the Brahmaputra valley. Under Captain Ryder and Captain Rawlings an excellent route traverse was carried out, and parts only very imperfectly known before were mapped.

The Afghan War of 1879–80 is another example, and the dispute concerning the Russo-Afghan boundary, which nearly led to serious complications with Russia, resulted in the excellent survey by Sir Thomas Holdich, of the line of the northern boundary of Afghanistan, in 1884.

The wars in South Africa and numerous other examples could be quoted to show that much of the early surveying has been the outcome of military expeditions.

As many of you are aware, there had long

remained a small section of the Brahmaputra that was unknown, that part of the course of the river where the great bend occurs just before the river reaches the plains of India. Quite recently this has been mapped—with the exception of a few miles—by Captain Bailey, again as the outcome of military expeditions sent to teach the turbulent tribes that they cannot murder British officials with impunity.

Yet it is remarkable that although warlike operations have so often led to the surveying of hitherto unmapped regions, the risk of war or of complications that might lead to it have not infrequently been a hindrance to surveying, and many parts adjacent to our frontiers could have been surveyed long ago had there been no fear of political difficulties arising.

Just to the north of India is the most interesting country of Nepal, containing the highest mountain on the earth, and yet there is no part more imperfectly mapped. Many an adventurous explorer has cast wistful eyes in that direction, but so far none have been permitted to cross the border for surveying, with perhaps one or two exceptions to do a piece of special work and quickly return.

Among other expeditions that have resulted in surveying, or at least rough map sketching, might be mentioned those for the delimitation of boundaries, commercial or industrial undertakings such as gold-mining and land development, and projects for new railway lines, all of which have occasionally been fruitful in good cartographical results. Nor must we forget Christian missions. The better-trained missionary has always recognised the importance of some sort of survey of the remote field of his operations and the route to it, if for no other reason than to assist his fellow-workers and those who come after him; and in the earlier days specially a great deal of route surveying and mapping was done by the self-sacrificing labours of the missionary. We have only to think of the work of the early Jesuit missionaries in China and Japan, and of that of such men as Moffat, Livingstone, Rebmann, Grenfell, Arnot and others in more recent times, to be reminded of how much geographers owe to the missionary.

Most of the expeditions referred to so far have not had surveying as their primary object, and such as has been done has been incidental on the necessity for prosecuting the main purpose in view; but the properly-equipped surveying expeditions that have been despatched from this and other countries have, during recent times, added enormously to our knowledge, whether the more exact Government trigonometrical surveys undertaken for geodetic purposes, or those whose only object it has been to produce a good topographical map.

In times gone by geographical and topographical surveying has been too much carried out by numerous independent agencies of different nationalities, acting pretty much in a limited sphere, and without any mutual coordination. What has been lacking is the treating of the subject as one connected whole, and dealing with the survey question not from a national but an international point of view. There have been many opportunities lost of extending a triangulation or carrying on topographical surveying, just because it would mean passing over a boundary line, or crossing into the territory of another nation.

In the short time given to this lecture I cannot attempt to describe, however briefly, the various Government trigonometrical surveys of European and other countries to which reference has already been made; but I should like to say a few words here about the triangulation of our own Ordnance Survey.

The first base-line for the survey, in England, was measured by General Roy on Hounslow Heath in 1783 with wooden rods tipped with bell metal. The rods were supported at the ends by stands, and each measured 20 ft. 3 in. Later on Colonel Calderwood substituted glass rods for the wooden ones, but the distance obtained by both the wooden rods and glass ones agreed very well, and was taken as 27,404·0137 ft. at a temperature of 64° F.

In 1827-28 a base-line was measured near Lough Foyle in Ireland with a new apparatus known as Colby's Compensation Apparatus, and with the same apparatus the Salisbury Plain base in England was measured in 1848.

It is interesting to note that the difference between the measured length of the Salisbury Plain base and its length as computed by the triangulation from the Lough Foyle base only amounted to 4·6 in., although the distance between the two is something like 345 miles.

A few years ago some attention was turned to the Ordnance Survey in connection with certain loose and vague statements that were current as to its not being accurate enough for the modern requirements of geodesy. People who knew little of the subject began to run away with the idea that the Ordnance maps were not so accurate as they were supposed to be after all, which was, of course, absurd, and entirely

due to a misunderstanding of the facts. Apart from furnishing the basis of our maps the triangulation is of the greatest importance from a purely geodetic point of view, since it forms the northern portion of the western arc of the meridian of Europe and Africa, and the western portion of the great European arc running from east to west along the 52° parallel of latitude.

Many improvements have been introduced in instruments and methods since this triangulation was done, nearly 100 years ago, and the question was raised by geodesists as to whether the work, although of course sufficiently reliable for mapping purposes on any scale however large, was quite up to the modern standard, so that it could be safely used in the discussion of the lengths of arcs for obtaining the true figure of the earth. The matter having been raised at two meetings of the British Association, in 1909 it was decided to test the accuracy by measuring an entirely new base far away from the original Salisbury Plain and Lough Foyle bases, extend a triangulation from this new base to certain stations of the old triangulation, and see how the sides computed from this new base agree with the original values. The position of the new base, measured with invar tapes, was Lossiemouth, on the shores of Moray Firth, on the east coast of Scotland, and the work was carried out with every refinement by Major W. L. Johnstone and Captain H. St. J. L. Winterbotham, of the Royal Engineers, under the direction of Colonel C. F. Close, C.M.G., R.E., Director-General of the Ordnance Survey.

Detailed reports have been published by the Ordnance Survey Office, and Colonel Close, in his "Notes on the Geodesy of the British Isles" which appeared in 1914, sums up the matter as follows:—

"We may, I think, safely say that the published length of any side of the principal triangulation is not likely to be in error by a

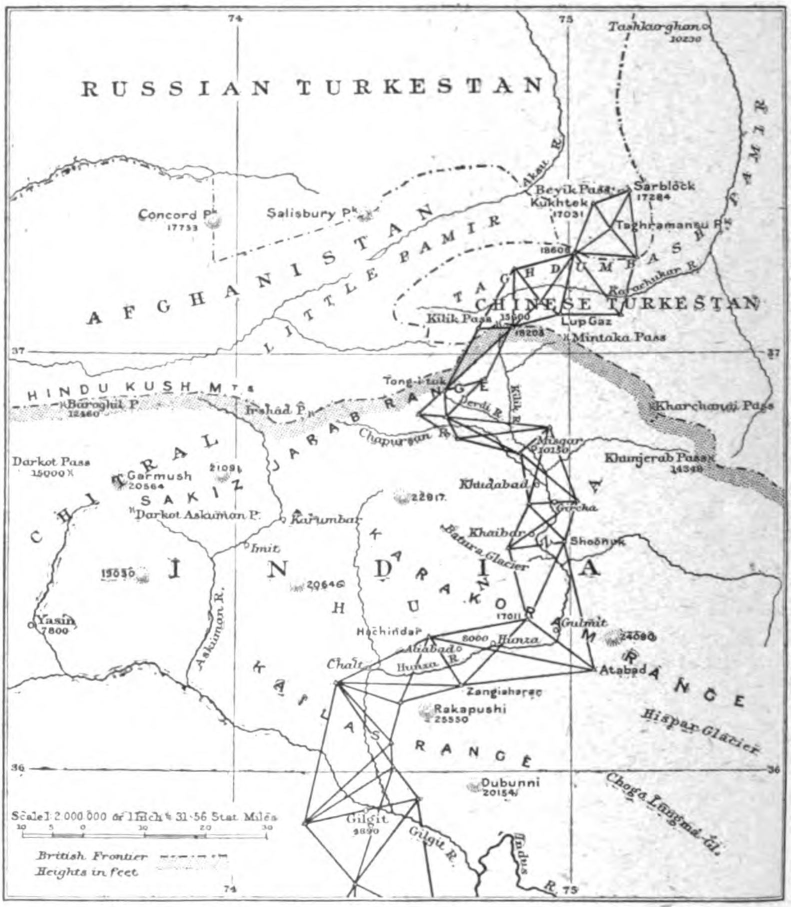


FIG. 15.—THE INDO-RUSSIAN TRIANGULATION CONNECTION.

quantity much greater than 1 inch in a mile. It may be noted that American geodetic regulations allow a maximum discrepancy of 2½ inches in a mile. The probable error of an observed angle is 1″·23, or about three times as large as would be expected in modern work, but the strength of the network largely compensates for this. Not very much would be gained by re-observing the angles of the triangulation along the line of the two arcs, and the expense would be considerable, not less, I suppose than £20,000."

A large amount of triangulation work has been done in recent years in hitherto imperfectly mapped parts of the earth, and although a line of triangles run across a country does not in itself constitute a topographical map any more than the skeleton-like framework of a new building to be erected constitutes the building, yet it answers much the same purpose, and enables the topographer to adjust his map accurately to definitely fixed points of the chain of triangles, and binds the whole together.

Many such chains have been run recently, and I should like to call attention to one or two of these, which must have a very important influence on future mapping.

The accurately determined points of the great trigonometrical survey of India, in the Himalayas and the frontier regions, have for a long time past been used for the extension of surveys into the little known countries beyond the borders of India; but until just recently there has been a gap between this remarkable triangulation and that of the Russian Government far to the north. During the International Geodetic Conference of 1909, which met in London, the question of connecting these two triangulations was discussed, and its importance from a geodetic point of view pointed out. The Survey of India undertook the work, and Lieuts. Bell and Mason, with other survey officers, commenced operations in 1911, and carried a chain of triangles by way of Gilgit, Hunza, over the Karakoram range to the Kilik Pass, the Pamirs, and thence into Turkestan. Fig. 15 shows this important piece of triangulation, but it gives no idea of the difficulties under which the work was accomplished. What with the continual climbing of almost inaccessible ranges and peaks, the severity of the climatic conditions and difficulty of transit, the work was indeed most arduous, and poor Lieut. Bell lost his

Fig. 16.—Geodetic Arcs.

life in carrying it out, doubtless through the strain and exposure. Still it is done, and will in the future be of the greatest value, not only from a purely geodetic point of view, with which it was primarily undertaken, but as furnishing definitely fixed points for future surveyors in this region. (See *Geographical Journal*, June 1914.)

Fig. 16 shows the principal chains of triangles on the earth which have been run chiefly for geodetic purposes, although they also serve to form the basis of mapping.

In Africa, valuable work of this kind has been carried out in recent years, and the line of triangles which you see running right across the continent from the Cape to Egypt is likely to hold a most important place in the future mapping of Africa, as well as constituting a most valuable transcontinental arc which will be of the greatest importance to geodesy. The work, so far as it has been completed, was carried out in South Africa under the superintendence of the late Sir David Gill. Starting from the triangulation of the Cape, it passes through the Orange Free State, Transvaal and Rhodesia, right up to the southern shores of Lake Tanganyika. Then there comes a break. It was hoped that the Germans would see their way to carry it through their territory, but as things are now, we may have the pleasure of doing this piece of the line as well, not through German but British territory. To the north of Tanganyika the triangulation has been further completed in the neighbourhood of Mount Ruwenzori, and some day it is sincerely desired that it may continue down the valley of the Nile to Egypt and the Mediterranean. The Egyptian triangulation is in an advanced state, and when money is forthcoming let us hope that this most important piece of work will be finished.

If in years to come this triangulation can be connected with the European arc, extending to the Arctic Ocean, it will add enormously to the accuracy of the geodetic measurement for obtaining the figure of the earth.

As a basis for survey work in Africa, the line has already proved valuable, and will be more so as time goes on, since it gives the most needed points to which secondary triangulation and topography can be adjusted. The official reports of the geodetic triangulation are published, and provide excellent examples for those who may have to undertake anything of the kind at a future time.

In Africa, as you have seen, much of the mapping depends on the roughest kinds of surveying; but during the last twenty years the accurate demarcation of international boundaries has been in steady progress, and the stations of the triangulation constitute the points to which the topographical surveys of the interior regions can be adjusted.

The international triangulation between British and German East Africa has proved of the greatest value in this respect, and since its extension round the northern shores of Victoria Nyanza to Lake Albert and Mount Ruwenzori, it has been possible to produce excellent topographical maps of the adjacent regions. The triangulation of the western part of Uganda (Buganda as it is called) was based upon this, and the topographical map of this province is one of the best of its kind in existence.

Although in the south the surveys of our East African Protectorate have advanced considerably, there are parts in the north and centre of the country that are hardly explored, much less surveyed, and such work as has been done is of an isolated and disconnected character.

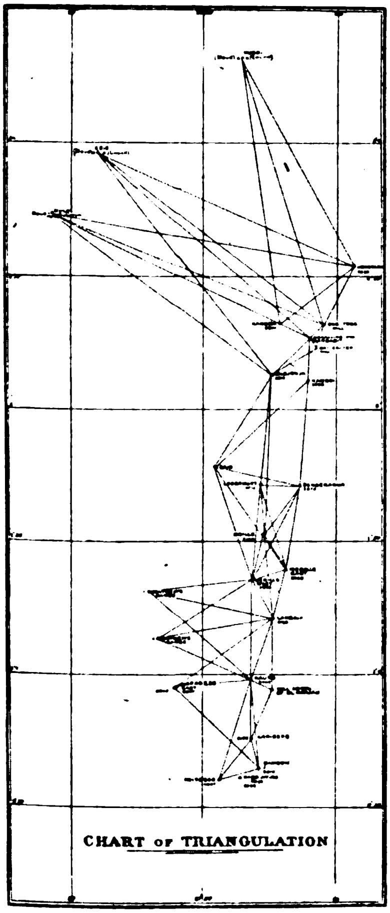
A most important piece of surveying was carried out in 1909–12 by Mr. G. F. Archer, which was the connecting of the triangulation of the south, near the waters of the Uaso Nyiro, with certain points fixed by Captain Maud and Major Gwynn on the Abyssinian frontier; and although this chain of triangles was rapidly run, and not of the highest order as regards accuracy, it is quite good enough for mapping purposes, and will furnish the most needed points from which the future surveys of the country can be carried to the unsurveyed parts to the east of the line. Fig. 17 is taken from a map showing Mr. Archer's work, which was published in the *Geographical Journal* for November, 1913.

Other examples of recent triangulation that have had, and will have in the future, an important bearing on topographical mapping, could be mentioned, such as that of the Chile-Argentine Boundary Commission, and the still more recent piece of work along the boundary between Peru and Bolivia, of which Sir Thomas Holdich gave an account a short time ago in the *Geographical Journal* (February, 1916), and which was, to a great extent, carried out by my old pupil and friend Captain Toppin—who, like so many other excellent men, was killed soon after the outbreak of the war. I have only mentioned a few examples, but shall be pleased to furnish particulars of any others if those interested will apply to me at the Royal Geographical Society.

I propose now to deal with some examples of route surveying and mapping, taking them from the work of early travellers as well as from those of a later date.

As you have already seen, about two-thirds of the earth's surface is at present mapped only in this approximate manner.

Beginning with the route traverses and maps of early travellers, the first (Fig. 18) I shall show you is the map made by Dr. D. Livingstone of his famous journey from Bechuanaland to Angola. You will remember that he left the mission station of Kuruman in June, 1852, where Dr. Moffat, his father-in-law, laboured so long, travelled through the then unknown region to the north, by way of the Upper Zambezi, and finally came out at St. Paul da Loanda, on the west coast. It was during this journey that he first heard of the Victoria Falls, and although he did not actually visit them till later, he placed them on his map from native information.



Dr. Livingstone was a good observer with a sextant, and determined astronomically the position of numerous places on the route, while the actual mapping was done by compass traversing.

After a short stay at Loanda a start was again made with the object of travelling right across the continent from west to east. During this journey he struck the Zambezi again, and followed the river right down to its mouth, discovering the Victoria Falls on the way. The original of the map made on this journey and the one just shown are in the collection of the Royal Geographical Society, as are also the sextant and boat's compass used by the famous missionary-explorer in navigating his boat down the Zambezi.

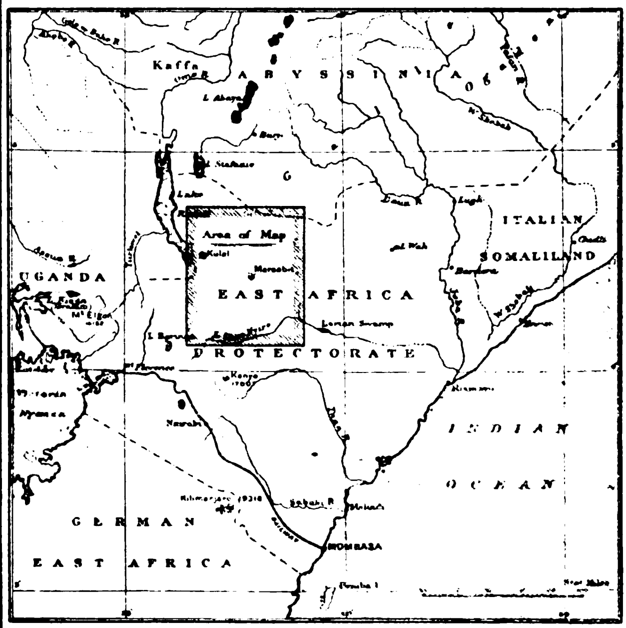


FIG. 17.—ARCHER'S TRIANGULATION IN EAST AFRICA PROTECTORATE.

When compared with recent maps Dr. Livingstone's first route maps are remarkably good, taking all things into consideration—far more accurate in many respects than some later route traverses in the same part of Africa.

Captain Speke's manuscript map of the journey he made with Captain J. Grant from Zanzibar to Lake Tanganyika in 1858 is also an interesting example of pioneering work and another of the Royal Geographical Society's treasures. This was the first time the country had been

traversed by Europeans, and the map is therefore important.

Considerable improvement has been made in recent years in the instruments used in route traversing and surveying, and in the methods employed; but in these early days the usual equipment was a sextant and artificial horizon, a chronometer or watch, prismatic compass, boiling-point thermometers and aneroid; and it was with these that most of the work shown by the third degree of shading on the map, *i.e.* those regions mapped from route traverses and sketches, was, until quite recently, carried out. With the sextant and artificial horizon the astronomical observations for latitude and longitude were taken, as well as those for finding the

FIG. 18.—DR. LIVINGSTONE'S MAP.

error of the compass. The route was plotted from the compass bearings, and adjusted to the astronomically determined positions. The latitudes were usually from meridian altitudes of the sun or stars, and the longitude from altitudes taken east or west of the meridian, or if the man knew his work properly, and could manage it, by both. The local time thus found was compared with the times shown by the chronometer, which was supposed to give the Greenwich Mean Time, and the difference was taken to be the longitude of the place.

The sextant, if in good adjustment, in the hands of a man accustomed to it, is capable of giving results in latitude that should not be more than 10″ or 20″ in error, and the local time should not be far wrong, although the accuracy cannot be expected to be anything like equal to that obtainable with a theodolite; but for azimuth or finding the true bearing of a point it is not very suitable, since the angle observed between the sun and the distant point selected is not the horizontal angle, and has to be reduced to this by a somewhat lengthy computation.

An ordinary observer has no means of testing accurately the centering or graduation errors of a sextant, and a great drawback to its use for survey work is that it is impossible with it to measure accurate horizontal angles, since unless the points are all exactly at one altitude the angles will be too large. The sextant is essentially a navigator's instrument, and nowadays it has been almost entirely superseded by the theodolite in land surveying.

As regards the longitude, the difficulty was to obtain a steady rate for the chronometers, owing principally to the unavoidable oscillations and concussions they met with in transit. Sometimes lunar distances were observed for obtaining the Greenwich time instead of trusting to the chronometer; but these, even with the utmost care, are very unsatisfactory, and the results obtained unreliable. I have had to compute hundreds of lunars, and my experience goes to prove that they are far too uncertain to be of any service in present-day geographical surveying. I well remember, on one occasion, having to work out some of these observations for a noted traveller in Africa, whose name you would all know, and they placed him anywhere between the Indian Ocean and the Great Lakes.

In more recent years the occultation of a star method of finding the longitude has almost entirely superseded lunar distances, as this gives more dependable results; but all of these so-called "absolute methods" of finding longitude are now fast being superseded by the introduction of triangulation and either ordinary or wireless telegraphy.

Heights of the land were usually obtained by the boiling-point thermometer or aneroid, since the mercurial barometer is not convenient to carry, and very liable to be broken.

Such, then, was the general equipment of the pioneer explorer and geographical surveyor in the early days of, say, from twenty to sixty years ago; and in many respects, for rapid pioneering journeys, it is much the same to-day, except that a small theodolite usually takes the place of the sextant and artificial horizon, and the

plane-table has come into general use. For more important geographical survey work the outfit is now more elaborate, and this will be dealt with in my next lecture. With such an outfit as that just mentioned, the greater part of the first mapping of Africa, and other unexplored regions of the earth, was carried out, with results that were more or less reliable according to the skill of the explorer and the time and opportunities at his disposal.

When I first became connected with the Royal Geographical Society, one of the things I remember doing was to place the instruments to be taken by Keith Johnston on a table for his inspection, just before he started on his journey from Zanzibar inland towards the Great Lakes. This was in 1878.

You may remember that this young pioneer-explorer's life came to an early termination before he had been long on this expedition, and the work was completed by the geologist, Joseph Thomson, who afterwards so successfully carried out the mission entrusted to him by our Society of exploring the region, then almost entirely unknown, between Mombasa and Victoria Nyanza. The route survey he made was of considerable importance, and was really the first piece of surveying done in the region, except just near the coast.

It is not only Africa, but Central Asia, South America, Australia, and the Polar regions have all to a great extent been mapped from route surveys made in much the same manner in times past, and many examples could be referred to; but those given may suffice to show the kind of work done by the earlier explorers of the last century.

I will now refer briefly to a few of the more recent examples of geographical surveying and mapping.

As already mentioned, the plane-table has recently come into more general use, and where the country is suitable and the topographical details can be adjusted to triangulation points, excellent results can be obtained. As an example of this sort of surveying, the map of the Siachen Glacier in the Karakorum region is worthy of attention. This map is from the surveys of my pupil, Mr. Grant Peterkin, who accompanied the Workman Expedition of 1912, and was published in the *Geographical Journal* for February, 1914. All the available points fixed by the triangulation of the Survey of India were first carefully laid down, and these were supplemented by others determined by a 5-in. theodolite by Mr. Peterkin himself as the work progressed. The triangulated points served as a basis for the plane-tabling, and the glaciers, ridges, peaks, and other topographical details were carefully adjusted to these triangulation points. Heights were principally obtained from theodolite or clinometer vertical angles, and were dependent upon the known heights of the triangulation, supplemented by hypsometrical observations.

The survey work in Central Asia varies a great deal in its reliability. For instance, while most of Tibet is mapped from the roughest sketching, there are certain sections of it that are from surveys of a higher standard. The survey of the British Expedition to Lhasa of 1904 is an example of this latter, for during the journey west of that place a traverse was carried along the valley of the Brahmaputra by Major Ryder and Captain Rawling, and the latter officer afterwards did some excellent mapping in Western Tibet and Kashmir. These surveys were published by the Survey of India, and reductions of them appeared in the *Geographical Journal.*

Some of the more important expeditions have been accompanied by officers of the Survey of India, even when the expedition has been a private enterprise; and the results as regards mapping have naturally benefited considerably by this arrangement.

Such was the case with regard to the Workman Expedition just referred to, to which was attached a native Indian plane-tabler, and with the journeys of Sir Aurel Stein, who has done really excellent survey work in Chinese Turkestan and in the mountainous region between there and India. Mention may be made of the recent remarkable expedition of the Italian explorer, Dr. de Filippi, who in 1913–14 conducted a thoroughly well-equipped scientific expedition from India to the Karakorum region, and thence to Yarkand and Kashgar. The final plotting of the results of the journey is now being done in Italy, and this should be most valuable.

The expedition was accompanied by the well-known Indian Survey officer, Major Wood, R.E., and two native Indian surveyors, besides several Italian surveyors, and the work consisted of theodolite triangulation and plane-tabling, supplemented by photographic surveying. An interesting feature was the determining of the differences of longitude by wireless telegraphy, which was most successful. Time signals were sent from the wireless station at Lahore and received simultaneously at the headquarters of the Trigonometrical Survey of India at Dehra

Dun, and, with the greatest clearness, by the surveyors at their various stations right over the Himalayas.

From what has already been said, it will be certain that the old rough-and-ready methods of route surveying are fast being superseded by more exact methods. The recent improvement in the micrometer theodolite, and the manufacture of light and portable forms, specially the 4-inch tangent micrometer theodolite, has made it possible for a traveller to carry with him a really good and useful instrument capable of considerable accuracy, with which he can not only take rounds of horizontal angles, but astronomical observations for latitude, longitude and azimuth of a higher degree of accuracy than was possible by his predecessors with a sextant and artificial horizon.

A useful piece of route surveying of this kind is that of Mr. C. Clementi, who in 1907–8 travelled from Kashgar through Chinese Turkestan and Western China to Canton, a journey of altogether about 4,000 miles, during which he fixed 141 places in latitude by north and south stars, and 139 places in longitude by a careful series of chronometric differences, by means of half-chronometer watches, with east and west stars for local mean time. To these astronomically-determined positions the route traverse has been adjusted, and the whole is a most creditable and useful piece of work. A list of the positions determined and a map showing the places appeared in the *Geographical Journal* for December, 1912.

I have specially referred to this here in connection with route surveys, as it is a good example of what can be accomplished by individual enterprise in mapping a route with small instruments.

If the longitudes could have been determined by wireless telegraphy they would doubtless have been more reliable still, but at that time this was impossible.

A similar piece of route surveying was carried out in South America, with the same kind of instruments, by Dr. Hamilton Rice in 1912–13, who travelled from Bogota, in Colombia, to the Rio Negro and Amazon, through an entirely unexplored region; and a map, with description of the journey and surveys, was published in the *Geographical Journal* for May, 1914.

The determination of longitude by wireless telegraphy has been undertaken with great success in recent years in connection with the Bolivia-Brazil boundary survey. Much of the country through which the boundary line passes is thick tropical forest, dense undergrowth, and along the courses of the Upper Amazon tributaries, so that a regular triangulation was quite out of the question; and all that could be done was to carry a careful traverse through this difficult jungle region. The work was first undertaken by Major P. H. Fawcett, R.A., and completed by Commander H. A. Edwards, R.N.R. During the latter part of the survey Captain Edwards determined the longitudes by wireless telegraphy, and an interesting description of the methods and results was given in the *Geographical Journal* for May last. It may be noted in passing that it was previously supposed to be almost impossible to send wireless signals for any great distance in the tropical forests of South America, but Captain Edwards's results were most satisfactory, and prove that, when properly carried out, there is little difficulty either in sending or receiving.

In connection with the present state of the mapping of the earth, I have dealt at considerable length with the subject of route traversing. I have done this first of all because at the present time by far the greater part of the earth's surface is still only mapped in this way, and in many regions it will doubtless be impossible to do anything more accurate for years to come, and it will be long before the darkest shade on our map is likely to extend to the remoter regions of the globe.

Before leaving this part of our subject, I want to say a little about the kind of surveying that is usually carried out by explorers in the Polar regions, and from which most of the mapping there has been done. As was apparent from the maps showing the state of surveys, it is in the Arctic and Antarctic regions that a large amount of the area of the earth still unmapped exists, which is what might be expected, considering the serious climatic and physical difficulties met with in penetrating into these regions. Such surveying as has been attempted has been carried out at the risk and sacrifice of many noble lives, and considering the circumstances it is not to be wondered that it is not as a rule of the highest order of accuracy.

Apart from climatic difficulties, there are others that render surveying in the Polar regions by no means an easy matter. Near the Poles the magnetic compass is most unreliable, partly because the "dip" is so great that there is very little directive horizontal force, and partly because the "variation" is changing so rapidly that in many places an alteration in position of

a few miles makes a considerable difference in its value. Then again, it is only possible to travel in daylight, so stars can but very rarely be used except at, or near, winter quarters; and, consequently, all astronomical observations must be made by the sun, which is generally so low that the refraction becomes uncertain. Still, latitude can be observed fairly well as a rule, since all that is required is to be sure that one has obtained the highest altitude; but longitude is another matter, as the change in altitude of the sun is so small for a considerable interval of time that it is almost impossible to get the local time with sufficient accuracy with such instruments as are usually carried, certainly remarkable, under the circumstances, that the position of the Pole as fixed by Amundsen about a month before, with a sextant, differed only from Scott's determination by about half a mile.

At the North Pole, Peary used a sextant and artificial horizon, and so have many others on Polar expeditions. After Peary's return, I took sextant and theodolite observations at low angles for the sake of comparison. These were made as a result of Peary's observations, since some persons at the time seemed to think that it was impossible to take observations with a sextant and artificial horizon at such low angles as 7°. The comparison shows that even

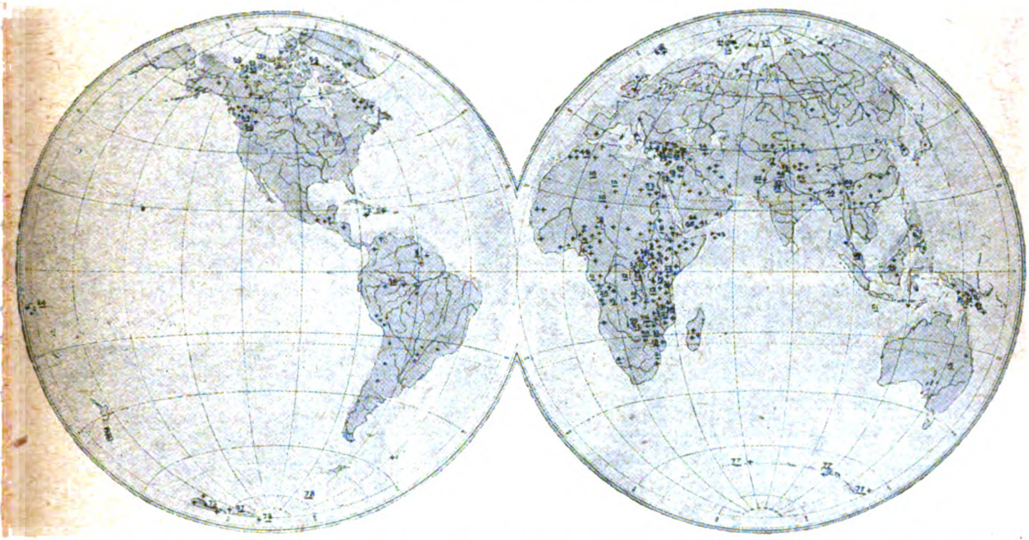


FIG. 19.—EXPEDITIONS TO WHICH THE ROYAL GEOGRAPHICAL SOCIETY HAS GRANTED MONEY AND LOANS OF INSTRUMENTS.

and under the trying circumstances in which the explorer finds himself.

It has become the custom now to take a small 3-inch or 4-inch theodolite on the journey to the Poles, and on Shackleton's remarkable expedition of 1907–9 the latitudes were observed with one of these. Distances were measured with a sledgeometer, and rounds of angles were obtained at every convenient halt to the different peaks and points along the coast. Compass bearings were read, and the variation found, by equal altitudes of the sun before and after the meridian passage. Heights were obtained from boiling-point readings and vertical angles. Subsequent expeditions have proved that, on the whole, this was a remarkably good piece of work.

Captain Scott on his last journey to the South Pole also took a small theodolite, and it is at 3° the sextant and artificial horizon observations differ only by about 1′ from those taken with a theodolite.

From its very foundation the Royal Geographical Society has had a remarkable influence on the surveying and mapping of the earth's surface, and specially those parts of it which have been previously but little known or entirely unexplored. I think it must be admitted that its influence has increased as years have passed, and it is no exaggeration to say that it has done more in this respect than any other body. It is therefore, perhaps, fitting that I should close this lecture with some account of what the Society has accomplished, specially as it has a direct bearing on the subject before us.

It is not only by the awarding of annual medals to explorers and surveyors, whose journeys have

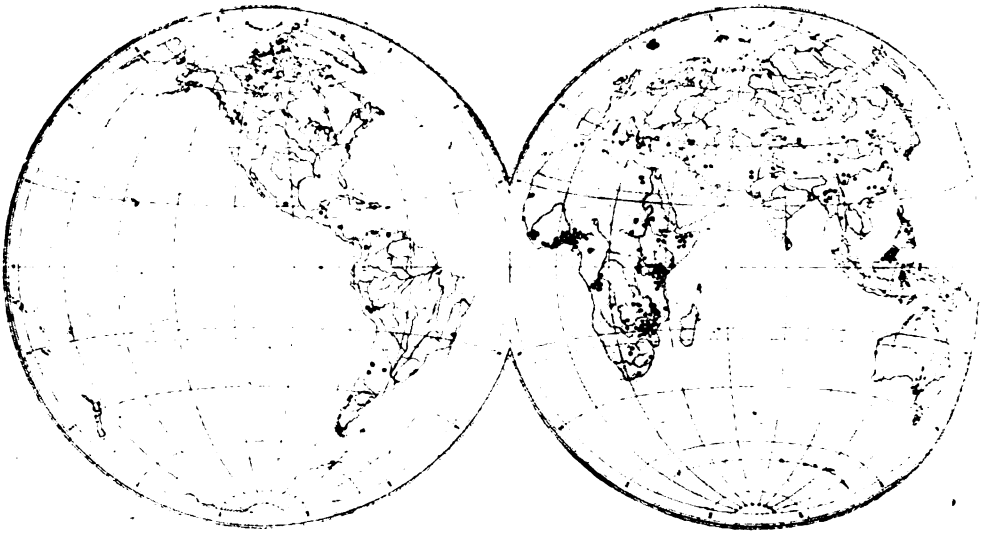


FIG. 20.—ROYAL GEOGRAPHICAL SOCIETY SURVEY PUPILS, 1879-1897.

resulted in the more accurate surveying and mapping of the world, that the Society has stimulated and encouraged geographical research, but it has also assisted financially a large number of expeditions, and the money thus granted has enabled many a man to carry his explorations to a successful issue which he otherwise could not have done for the want of funds. Still more frequently has it been the case that travellers going into little known parts of the world have been granted loans of surveying instruments, which they could not have purchased themselves; and, thus encouraged, they have brought back excellent cartographical results.

Altogether 331 expeditions have been lent instruments, and about £38,500 have been devoted to grants of money to further geographical exploration and surveying by the Society.

I have tried to represent something of the work the Royal Geographical Society has done in these two ways graphically on a map, which I will now give. In Fig. 19 the crosses show the regions which have been mapped, at any rate partially, by expeditions to which instruments have been lent, while the figures represent those expeditions and the field of their operations towards the expenses of which money grants have been made.

There is still another way, by no means the

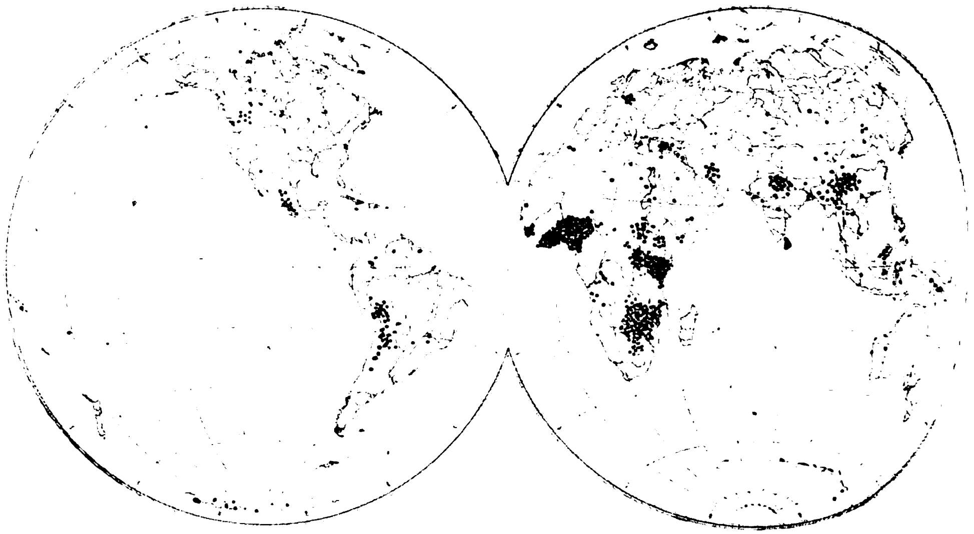


FIG. 21.—ROYAL GEOGRAPHICAL SOCIETY SURVEY PUPILS, 1897-1916.

least important, in which the Royal Geographical Society has done much to promote geographical surveying, and that is by providing suitable instruction in the work of surveying for travellers. It is all very well to grant money and lend instruments, but the important thing is that a man should know how to make use of the money and the instruments lent so as to take proper advantage of opportunities afforded, and to make the best possible surveys and maps of the regions visited.

In the early days of the Society a traveller had to pick up this requisite knowledge as best he could, but in 1879 a scheme of proper instruction was started at the suggestion of the late Sir Clements Markham, who was then one of our honorary secretaries. This had small beginnings, but in recent years has made rapid strides, until at present it forms one of the most important branches of the Society's work. This course of instruction in geographical surveying, which has now been in existence for about thirty-eight years, was first conducted by my predecessor, Mr. John Coles, and since 1900 has been under my charge.

Altogether 730 surveyors and explorers have received instruction without reckoning special large classes of forty or fifty men each, from various parts of British Africa and elsewhere, who have during the past few years, before the war, been sent to us by the Colonial Office to learn the more elementary parts of compass traversing and mapping.

In order that you may obtain some idea of what has been done in this respect, and the progress the course of instruction has made, I have divided the thirty-eight years since its commencement into two parts of nineteen years, for each of which I have drawn a map which I now place before you (Figs. 20, 21). The first map deals with the period from 1879 to 1897, and the second from 1897 to 1916. The students are represented by dots, and these are in each case placed approximately in the region forming the field of operations. Where the expedition extended over a considerable distance I have tried to place the dot in the locality which formed the most important part visited by the surveyor.

By comparing these two maps a general idea can, I hope, be formed of the vast field covered by the Society's pupils, and the great increase in the number of students as seen by the far greater number of dots in the second map. In the first half of the period, that is from 1879 to 1897, there were 195 students, and in the second half, from 1897 to 1916, the number equalled 535, giving a total of 730 for the whole period of the course.

Some of these men have only obtained a few lessons and so gained a little knowledge, but others have been able to go pretty fully into the subject.

Men who have time to pass through the complete course of instruction can place themselves before a committee of the Society for examination, and if they pass obtain its Survey Diploma. Only comparatively few have had time to do this, the number being 75, or just over 10 per cent. of the total number of students.

Now as to the work remaining to be done. It is clear from the maps and figures I placed before you at the commencement of this lecture that this is considerable, as, notwithstanding the great progress that has been made, there is still only about one-seventh of the earth's land surface that can be considered to be accurately surveyed, and about the same amount not surveyed at all.

The need for men who can do really good work is increasing every year, and after the war is over it will be much greater. There will be new boundaries to survey and delimit, and many parts of which we have had to be content with incomplete and approximate maps will come into prominence and require to be properly surveyed; so the field will be greatly widened.

LONDON EVENING CLASSES.

The London County Council polytechnics, technical institutes, and evening institutes will reopen for educational work next Monday. It is especially hoped to secure the attendance of youths under eighteen years of age and of girls and women. Owing to the war youths below eighteen have largely taken up work of a less educative kind than formerly, and are now engaged in repetition processes which will cease to employ them when peace returns.

The facilities for evening education have been greatly improved, especially in the case of modern languages, for proficiency in which large prizes have been offered by the Chambers of Commerce and employers. After the war a knowledge of the languages of our Allies and of other nations will be of the greatest service, and a special feature is being made of classes in French, Russian, Italian, Spanish, and Portuguese, as well as in German.

The County Council is appealing to both parents and employers to encourage young people to join the classes as early as possible after leaving the day schools. Many employers already let their young employees leave business

early in order to attend the classes, and a general adoption of this plan would greatly help the junior institutes. Particulars can be obtained from the Education Officer, L.C.C. Education Offices, Victoria Embankment.

COMPRESSION TEST FOR KEEL BLOCK.

An important test was conducted recently by the United States Bureau of Standards to determine the ultimate strength of a cast-iron keel block. As designed, the block was expected to withstand a load greater than could be exerted by any testing machine in existence. It did withstand the full capacity of the Bureau's testing-machine (10,000,000 lb.) when the load was applied over the entire bearing surface of the block, but when the load was applied over part of its bearing surface it failed at 9,600,000 lb.

The test of the block itself was preceded by several preliminary tests to determine the strength of oak timbers, which are usually placed between keel blocks and the keel of the ship. At loads from 300,000 lb. to 800,000 lb. the timbers were completely shattered, the variation in the load depending entirely upon the variation in the area over which the load was applied.

After these preliminary tests the keel block was subjected to a load equal to the capacity of the machine. At about 6,500,000 lb. several sharp reports were heard, but after the full load was applied there was no apparent damage to the exterior of the block. On dismantling it, however, it was noticed that several of the webs of the various sections were cracked. It was then reassembled, and the load applied over a smaller area, when it failed at 9,600,000 lb. with a very loud report and almost complete shattering of the various sections, throwing parts of them to a distance of 12 ft.

OBITUARY.

Sir Cavendish Boyle, K.C.M.G. — Sir Cavendish Boyle died in London on the 17th inst., after an operation. He was born in 1849, a younger son of Captain Spencer Cavendish Boyle. His first official appointment was that of magistrate in the Leeward Islands, 1879. From 1882 to 1888 he served as Colonial Secretary in Bermuda, and after this he filled numerous Colonial offices, the latest being the Governorship of Newfoundland, 1901-1904, and that of Mauritius, 1904-1911. On leaving Mauritius he retired on a pension. In the year 1899 he took part in the discussion on Mr. H. A. Acworth's paper on "Leprosy in India," and soon after he became a member of the Society with which his elder brother, Sir Courtenay Boyle, had been connected since 1891. He also took part in the discussion on Sir Nevile Lubbock's paper on the West Indies in 1901.

GENERAL NOTES.

The Institute of Metals.—It will be remembered that when the Peter Le Neve Foster Prize was awarded to Mr. J. C. Moulden, A.R.S.M., M.Inst.M.M., for his essay on "Zinc, its Production and Industrial Applications" (which was published in the *Journals* of May 26th and June 2nd last), a very favourable opinion was expressed by the judges of the paper entitled "The Development of the Spelter Industry," by Mr. Ernest A. Smith, Deputy Assay Master of the Sheffield Assay Office, which was placed second in the competition. The latter paper was read before the Institute of Metals at their meeting on the 20th inst.

Indian Woods for Bobbins and Pencils.—In consequence of the war the supply of wooden bobbins from Europe required for Indian jute and other mills failed, and measures had to be taken to get them from elsewhere. According to a report of Mr. Cox, Imperial Forest Economist, a demand for suitable indigenous timber for bobbins arose in 1914-15. Thirty different kinds of wood were sent to a Calcutta firm from various parts of India, and these were duly seasoned before being tested as to suitability. The result has not yet been made known, says the *Pioneer Mail*; but it should be possible to find some Indian timber at least that will answer the purpose. Meanwhile, a cheap grade of bobbin has been imported from Japan, which, as usual, is on the alert for a fresh line of business. The lead-pencil industry, which has been stimulated by the war, is also in need of suitable wood. According to Mr. Cox, the *Juniperus macropoda*, from Baluchistan, upon which reliance has hitherto been placed, is becoming increasingly difficult to obtain, and the Calcutta pencil-makers have felt acutely the shortage of wood. Specimens of other timber from Madras, Sikkim, and Assam were experimented with, but no good substitute was apparently found for the juniper from Quetta. Further experiments are being tried, and it is to be hoped that they will be successful, as the lead-pencil industry, though of minor importance, is one that should have a future before it in India.

Sisal in the Philippines.—According to the United States correspondent at Manila, a determined effort is being made to develop the growing of sisal in the Philippines. Exporters of fibre are interested in the project. It has been found that the plant does exceedingly well in the islands, and that the fibre produced from it there is of excellent quality. The officials of the Bureau of Agriculture of the Philippine Islands are also lending their support to the propaganda for the cultivation of sisal. Already considerable plantings have been made, especially on the island of Masbate, and it is expected that within a few years the United States will become more independent of tropical America in obtaining a sisal-fibre supply.

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FRIDAY, SEPTEMBER 29, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

FOTHERGILL LECTURES.

The Fothergill Lectures on "Historic Buildings in the Western War Zone: their Beauty and their Ruin," by the Rev. G. Herbert West, D.D., A.R.I.B.A., have been reprinted from the *Journal*, and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

A full list of the Cantor and Howard Lectures which have been published separately, and are still on sale, can also be obtained.

PROCEEDINGS OF THE SOCIETY.

FOTHERGILL LECTURES.

SURVEYING, PAST AND PRESENT.

By Edward A. Reeves, F.R.A.S., F.R.G.S.,
Map Curator and Instructor in Surveying to the Royal Geographical Society.

Lecture III.—Delivered April 10th, 1916.

MODERN INSTRUMENTS AND METHODS OF GEOGRAPHICAL SURVEYING.

Last week I attempted to give a general idea of the present standpoint of geographical surveying, and to show by means of maps and diagrams what has been done during the past fifty or sixty years towards the surveying of the earth's surface, and what now forms the basis of our maps of various parts of the world. This afternoon I desire to say something about the more important instruments and methods employed by geographical surveyors at the present day.

As stated in a previous lecture, I propose to confine myself almost entirely to geographical surveying, or that branch of the subject which deals with the surveying of a considerable extent of the earth's surface on a scale sufficiently large and with the accuracy necessary for exhibiting all the main geographical features and topographical characteristics—in fact, to produce a good map of a country for general purposes. The points on such a map, on the scales of 1 : 125,000 or 1 : 250,000, should be accurate within the breadth of a pencil line, and if the work is properly carried out there is no reason why this should not be the case.

The principle underlying all surveying is much the same, and the whole subject really amounts to the best and most accurate methods of measurement with a view to representing on a plane, on a greatly reduced scale, the leading features of a certain area on the earth's surface in their relatively correct positions. Thus it resolves itself into a geometrical problem of similar angles and proportional distances.

This being the case it is clear that it becomes a question of correct angular and linear measurements and the computation of results; and all the improvements in survey methods have had for their object the increase of accuracy and facility in accomplishing these.

What we do now is exactly what was attempted by the early Greek geographers and others in ancient times, only we use far more accurate instruments and improved methods. If, for instance, we compare our modern micrometer theodolite with the old scaph of the Greeks, which was perhaps the first idea of an angular measuring instrument, or even with an early pattern theodolite, the contrast is striking. Many of these old instruments were extremely rough, and the angles could only be read with approximation, and to a great extent by estimation; and it could only be by chance, or by taking readings many times repeated, that any useful results were obtained. With the introduction of telescopic power and fine cross-wires in the seventeenth century, the vernier, and later the micrometer, it became possible to construct surveying instruments of great precision and accuracy. The theodolite, which is now frequently used in geographical surveying, has a circle of only 5 in. in diameter, yet with the micrometer it is quite easily read to 2″ of arc, or even as close as one second by estimation. When one comes to think of it, this is a marvel

of refinement, since it really means that we can measure to about $\frac{1}{50000}$ part of an inch, which is the space occupied by 1″ on the arc of a circle of 5 in. diameter. At least, this is the theoretical accuracy, but in actual practice there are, of course, errors in sighting, setting the micrometer wires, and those arising from other sources that have to be taken into consideration.

The continual striving after greater accuracy of measurement applies not only to angular measurement instruments, but to linear distance measurement as well; and the improvements in apparatus for this purpose, could we follow them in detail, would be most interesting.

From the rough methods that would naturally suggest themselves to early intelligent men, and some of which I referred to in a previous lecture, to the modern base-line apparatus, micrometer theodolite, and accurately computed sides of a geodetic triangulation is a far cry, and the advance in these matters is certainly remarkable. What would the ancient geographers have said if they could have been told of the accuracy of a modern triangulation, such as our own Ordnance Survey or of the Survey of India?

Still, absolute accuracy of measurement of any kind seems to be an impossibility, and the best we can do after all is to approach it as near as we can, and to arrange matters so that the errors will tend to balance one another.

Nature herself appears to object to perfection in measurement, even if other difficulties could be overcome. For instance, when we attempt to measure a distance, and have taken all precautions we can, change of temperature alters the length of our measuring tape, making it longer or shorter according to whether it becomes warmer or colder; and in spite of all that has been done by manufacturing tapes of alloys of different metals, in order to counteract this effect, change and uncertainty must exist to some extent. Then, as regards our angular measuring instruments, not only must there always be some imperfection in the graduation and centering, but the change of temperature affects the metal and again attempts to defeat our object of obtaining perfection. If we desire to measure the true vertical angle, there is always the troublesome and uncertain effect of the refraction of the atmosphere, which makes the mountain-top appear higher or in a different place to what it really is, according to the heat, moisture in the air, and all sorts of other unknown causes, which, in spite of all the corrections we may apply, occasion at least some uncertainty in our result; whilst in the case of the sun or star it is considerably worse. So great is this refraction, that when the sun appears to be just above the horizon as you see it over the sea, it is not there at all, and has actually gone down below the horizon. Of course, tables have been constructed for correcting all this, but no one can say that they are really accurate as the values depend so much upon special conditions, so that, in any case, they are only devices for making the best of a bad job.

There is another way in which Nature seems to do her best to show that she disapproves of our attempts at accurate measurement, and one which is most serious at times in its results, since it is often quite unsuspected—and that is the manner in which she pulls the spirit-level of our theodolites out of its proper central position. This is usually called the "deflection of the plumb-line," and it really means that the earth's crust is made up of irregular masses of matter so that the effect of gravity on the spirit-level or plumb-line is irregular; and as no one can tell exactly how much or in what direction this deflection is going to be, there is always an uncertainty of a second or two, and indeed sometimes much more, introduced in a latitude or other observation, however carefully they may have been taken. In quite a number of regions of the world, such as various parts of India, the British Isles, and the United States, experiments have been made to try and find out what the effect of this is, but there are far more places where nothing of the kind has been done, so that the geographical surveyor has always this sort of nightmare to haunt him, that his latitude and other observations, in spite of all his care, may not be so correct as they appear after all.

Again, as regards levelling, who can tell exactly what the mean level of the sea is upon which the difference of level depends? The best that can be done is to take a series of tidal observations at certain points over a lengthy period and accept the mean value; but the result would probably be different if taken at other times and in different places round the same coast.

Many other instances of the kind could be mentioned, and it is clear that in surveying, as indeed is the case with all other human effort, we are not likely to reach absolute perfection, however much we may strive after it and notwithstanding the astonishing degree of accuracy that has been attained. This being the case,

it is most important that whenever possible observations should be taken so that the errors have opposite effects and tend to balance one another.

The methods to be adopted in carrying out a survey must depend to a great extent, not only on the purpose of the survey, but upon many other circumstances, such as the time that can be given to the work, the funds available, and upon the character of the country to be surveyed. The latter is a most important matter, since it frequently happens that all else is controlled by it, specially as to the methods of determining the points to which the survey can be adjusted. For instance, there are parts of the world, such as the thick tropical forest region of the Amazon basin, the Gold Coast and parts of the Congo basin, where it is out of the question to carry out a regular triangulation, since it is not possible to obtain any extensive view, and so angles to distant points cannot be observed, and the surveyor is restricted to running traverse lines, which are checked and adjusted by the best means available. Again, in perfectly flat country with no prominent features, it frequently becomes necessary to adopt special methods. The question of transport and carriers also plays an important part. For instance, however desirable it might be to take large and accurate instruments and carry out triangulation in the Polar regions, except near the base stations and certain small areas more readily accessible, this has always been considered out of the question, chiefly from the difficulty of transport, climatic conditions, and the impossibility of devoting the necessary time to the operations without seriously delaying the expedition.

It is therefore clear that there are many things to take into consideration before undertaking a survey, and it is frequently impossible to follow the most approved methods, however much we may desire to do so. It really comes to it, as in many other things in life, that we have to do the best we can under the circumstances.

Still, whatever decision may be arrived at, there are fixed principles that should be always kept in mind, and a certain order in which the various operations should be performed—of which I hope to say something later on. First of all, we will deal with instruments, and although I cannot attempt a lengthy description of those now generally used, I desire to refer to some of the latest pattern, and call attention to a few of the important points in the construction of the instruments which are frequently overlooked by makers. Some of these are simple, although the accuracy of the work done may depend upon them.

Without doubt, the most important instrument for the geographical surveyor is the theodolite, and too much care cannot be taken in its selection, since a great deal of the whole work will depend upon this instrument. It is with the theodolite that the triangulation is performed which is to constitute the framework of the survey, and the fixing of points to which the topographical mapping is afterwards to be controlled and adjusted.

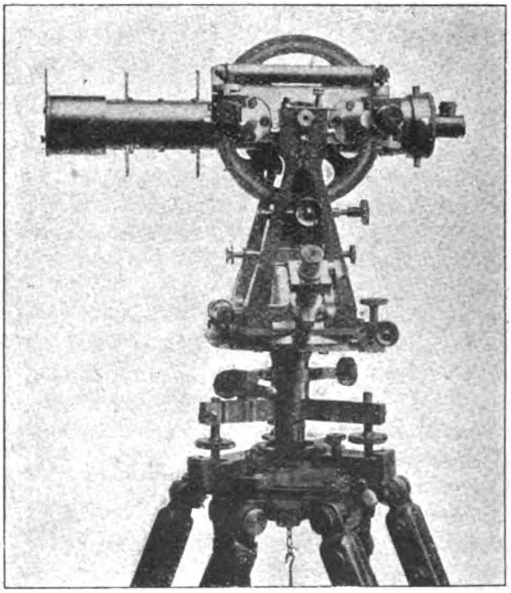

FIG. 22.—5-IN. MICROMETER THEODOLITE.

With this instrument are also taken such astronomical observations as are necessary for latitude, time and difference of longitude, and azimuth or true bearing, so altogether it is well to obtain a really good instrument.

The theodolite shown in Fig. 22 is a 5-in. transit, with micrometers divided to 10″ for reading the circles, such as is now generally used in the sort of surveying we are dealing with. You will remember that in the first lecture we traced rapidly the development of the theodolite from its early forms to the latest type of the instrument. For ordinary survey work it is not necessary to have such a heavy or elaborate instrument as this latter, and the one now shown has proved from experience extending over a number of years to meet

general requirements. It has been used extensively in the surveys of British possessions in Africa, on recent boundary surveys in South America and elsewhere, and has given satisfactory results. Although the micrometer "drums" are only divided to 10″, it is quite easy to read to 2″ or even 1″ with care, by estimation.

Whatever theodolite it is decided to take, there are certain features that should be carefully considered. For instance, the vertical and horizontal circles should be complete circles and not merely sections of circles or arcs, and the upright supports of the telescope should be long enough to admit of the reversing of the telescope with any eyepiece set to focus. In order to eliminate instrumental errors, all observations must be taken "face left" and "face right"—that is, with the face of the vertical circle first to the left and then to the right, as one looks through the telescope, except in the case of those astronomical observations in which the errors are eliminated by taking stars on opposite sides of the zenith.

Another important point is that the principal level should be on the vernier or micrometer arm, and not on the telescope as used generally to be the case with ordinary theodolites. This is most important for all accurate vertical angle observations, whether for astronomical work or otherwise, since it is necessary to note the reading of the level when each altitude is taken as well as the circle reading itself, and apply a correction. It will be clear that if the level is on the telescope it will revolve with it, and will be out of sight when the reading on one of the faces is taken; it would for other reasons be useless for the purpose in view.

It is true that when the theodolite is likely to be much used for running lines of levels as well as taking altitudes, it is convenient to have a level on the telescope; but it is better in that case to have an additional level.

There is quite a lot to learn about a theodolite in order to use it properly, and even the levelling of the instrument is not a thing that can be easily done, at any rate, with an instrument of this pattern, unless you know exactly how to do it.

If I were giving you a lesson in the use of the theodolite, there are many points beside those referred to with which we should have to deal; but you will find most of them explained in any good book on the subject.

Although the theodolite has many advantages over the sextant for geographical surveying, it is strange that it is only in recent years that it has been at all generally used, except on large elaborately equipped expeditions. One reason for this is that it has been considered too bulky and heavy for carrying on small expeditions. However true this may have been in the past, it does not hold good at the present time, as there are now several light forms with which it is possible to do quite useful work.

I was so constantly hearing of the difficulty of taking a theodolite on small expeditions where transport is a serious consideration, that some years ago I tried to remedy the matter by designing an instrument that should be portable and yet have all the latest improvements. The circles are read by means of special micrometers, which are, in fact, combinations of the tangent-screw and micrometer, so arranged that they greatly reduce the size and weight of the theodolite. The circles are 4 in. in diameter, and by means of the micrometer can be read to two seconds of arc. This instrument has, during the past six or seven years, been used on many expeditions with satisfactory results.

Even the extremely small 3-in. theodolite is quite a useful little instrument in proper hands, and has been taken on expeditions when no larger theodolite could be carried. As mentioned before, it was one of these that Shackleton and Scott took on their journeys towards the South Pole, and it has been used on other Polar expeditions. One of the latest instances of its use was on a journey through the centre of Arabia. Latitudes were obtained with it during this expedition three years ago, which, when compared with observations taken previously by other travellers at fairly well-known places, agree within 1′ of arc; and altogether I think we may consider that the observations are quite near the truth.

I have dealt somewhat at length with the theodolite; but there are many other instruments I might refer to. However, I shall only be able to say a little about a few of the principal of these in the time at my disposal.

While the theodolite gives the angular measurements, it is necessary that there should be some accurate means of obtaining linear measures or distances. For instance, while a triangulation would be relatively and proportionately correct, provided the angles were accurately measured, the actual lengths of the computed sides depend upon the accurate measurement of a base-line, and if this is in error the whole of the distances on the map must be wrong; therefore it is absolutely

essential that there should be some apparatus for measuring distances accurately. For rough route traversing, pacing or measurement by time, an estimated rate of travel is frequently all that can be managed, but in more exact surveying some better method has to be adopted.

To measure a base-line accurately is not such an easy operation as it may be at first supposed, and many things have to be taken into consideration, and to obtain a really good value needs the greatest possible care. Not only must the alignment be true, corrections be made for slope, and sag when the tapes are suspended on tripods, and the base reduced to the horizontal distance at sea-level, but corrections have to be made for the effect of expansion and contraction due to change of temperature.

for a change of 1° cent. instead of about $\frac{1}{204000}$, as is the case with steel, so that for all purposes of ordinary geographical surveying it may be considered invariable. The invar tapes have to be carefully handled, and must be wound on drums or reels of fairly large diameter.

Fig. 23 shows this base-line apparatus as it is when in use. The photograph was taken during Major Jack's survey for the continuation of the geodetic arc in Western Uganda, to which I referred in a previous lecture.

The tape itself commences at the connection near the inner tripod. Here a cord is fastened to the tape, and passes over a grooved pulley-wheel with ball-bearings, so as to reduce the friction as much as possible. Over the top

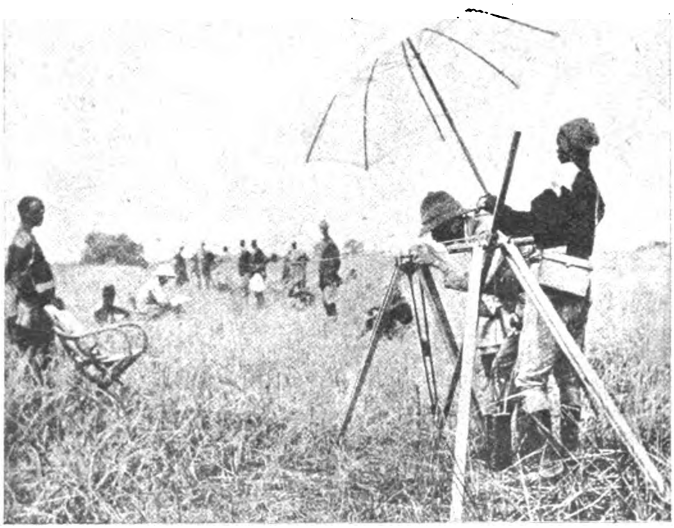

FIG. 23.—INVAR TAPE BASE-LINE APPARATUS.

The base-line apparatus of early days was bulky and generally heavy and difficult to carry about; but considerable skill and ingenuity has in recent years been exercised in the construction of light and portable apparatus, so that it could be carried on geographical surveying expeditions in rough countries; and the results have been most successful.

The difficulty of combining accuracy with portability has, I am glad to say, been practically overcome by the introduction of tapes made of an alloy of steel and nickel (containing 36 per cent. of nickel) called "invar," on account of its being almost invariable whatever the temperature may be. The expansion or contraction is only about $\frac{1}{1000000}$ of the length of the inner tripod is a very finely-divided scale for reading the lengths.

The tapes are of various lengths from 100 ft. to 400 ft., and 25 or 100 metres, and when in use are suspended between tripods at one tension by weights.

Having measured a base-line, or a section of it, it is necessary to mark its terminal points accurately on the ground, and there are various ways of doing this. In ordinary work it is sufficient to use a plumb-line, but when great accuracy is required this is not good enough, and all sorts of other methods have been attempted. The one that seems most satisfactory is the theodolite method. Two theodolites are placed roughly at right angles to one another. Each is carefully

levelled, and sighted on to the terminal point on the tape; each telescope is then lowered until the ground is sighted, and the mark placed

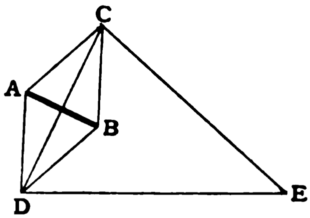

FIG. 24.—EXTENSION BASE.

where it can be seen exactly at the intersection of the central cross wires of the two telescopes.

One essential condition for all good triangulation is that the angles of the triangles should not be too acute or too obtuse, and this means that it frequently happens that a base-line sufficiently long or in a suitable position to give good intersections cannot be measured directly, in which case an extension base is resorted to. Here is an example of an extension base on the screen.

If AB (Fig. 24) is a measured base it will be seen at once that this is not long enough, nor in a suitable position for obtaining the lengths of the sides of the triangle CDE, so it is extended by triangulation to CD by measuring all the angles in the quadrilateral ABCD, and then from the base AB and the measured angles computing the sides AC and AD and BC and BD, and thence the side CD. CD can be computed two different ways, *i.e.* from the triangle ACD, and then from the triangle BCD, thus furnishing a good check on the work.

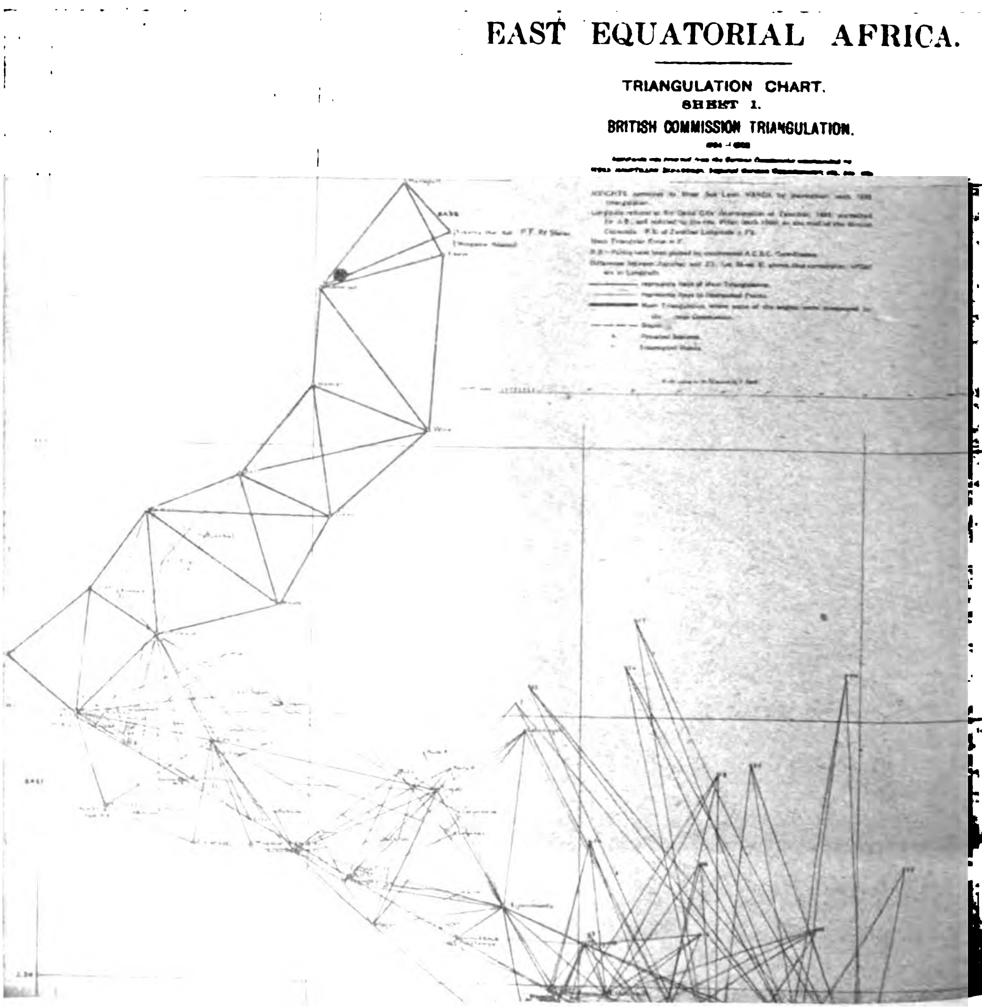

FIG. 25.—PART OF BRITISH EAST AFRICA TRIANGULATION.

I will now show two examples of triangulation taken from work done in recent years in connection with geographical surveying.

Fig. 25 is a specimen of the British East Africa triangulation, referred to in a previous lecture.

Fig. 26 is a part of the triangulation carried round the north end of Victoria Nyanza to the Belgian and German frontiers by Colonel Delmé-Radcliffe in 1902–4.

At the time of the so-called partition of Africa, it was decided that the boundary between the British sphere of influence west of Uganda and the Congo Free State should follow the line of the 30° meridian of east longitude, which was then supposed to run through the middle of Lake Edward, then but recently discovered by Stanley's expedition for the relief of Emin Pasha. However, Colonel Delmé-Radcliffe's triangulation placed the lake to the west of that meridian, which led to serious diplomatic discussion with the Belgian Government, and with Germany also, since it affected the German boundary to the south as well.

It should be a lesson for the future, as it shows the importance of having a good survey made before deciding upon boundary lines.

As already mentioned, owing to the features of the country, it is frequently quite impossible to carry out a regular triangulation; at least, it could not be done without enormous labour and expense. For instance, in the tropical forest region of parts of West Africa, such as the Gold Coast, it would be out of the question without first clearing away the trees, or erecting numerous high towers so as to get a distant view. The same is true of the recent South American Boundary Surveys of which we have read a good deal lately.

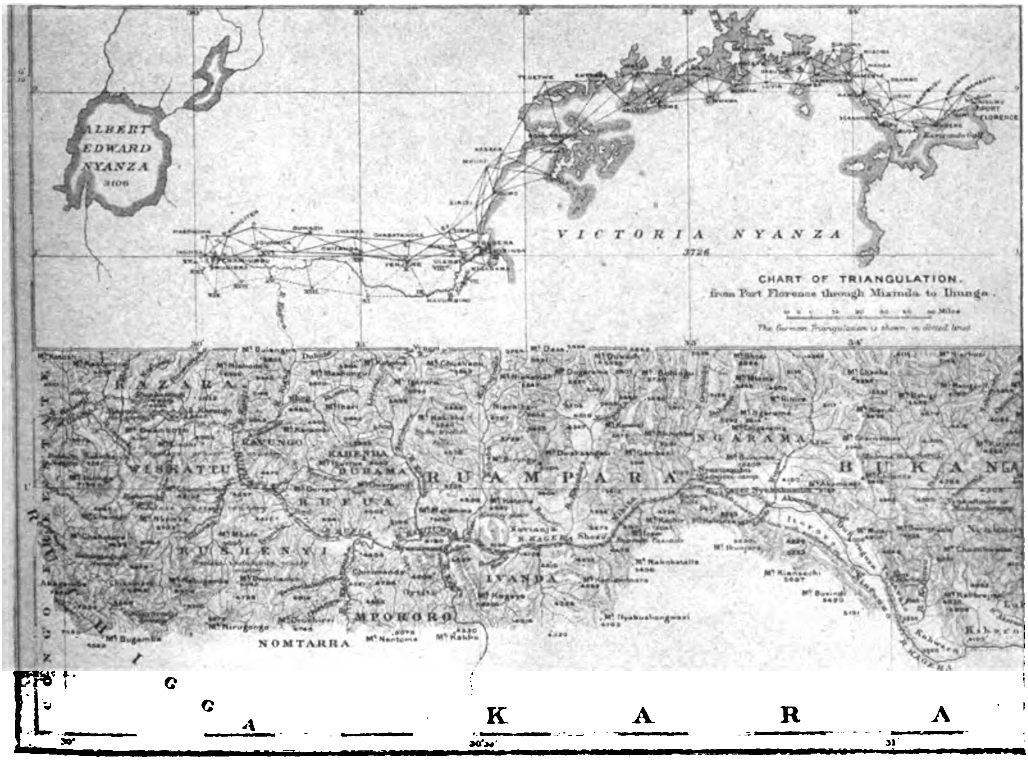

Fig. 26.—Colonel Delmé-Radcliffe's Triangulation.

When on the high mountain region of the Andes a triangulation could be run, but when this was left for the low forest region of the Upper Amazon basin to the east, triangulation became quite impossible as no distant points could be seen.

In these cases, when no triangulation can be carried out, other means of fixing definite points to which the survey can be adjusted have to be resorted to. The only way then is to run a traverse, as it is called, of some kind—that

is, to measure the distances between the points along the route and the inclination of the various lines, or "legs," of the traverse with one another. Thus, suppose a man travels from A to B (Fig. 27),

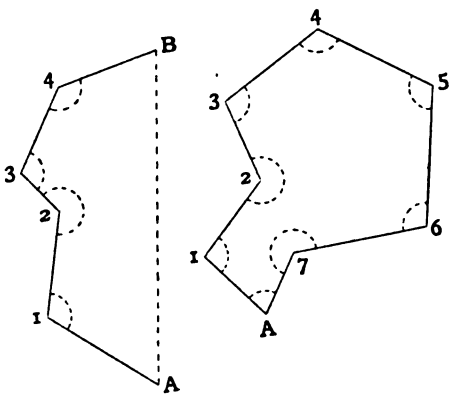

FIG. 27.—THEODOLITE TRAVERSE.

he would measure the distances A–1, 1–2, 2–3, 3–4, 4–B with a chain or tape, and the angles that one leg makes with another with a theodolite, from which the rectangular co-ordinates of all the stations can be computed, and the traverse corrected and closed, as it is called, if the points A and B are known. This is what actually takes places in the case of a theodolite traverse; and although the result is not likely to be so accurate as triangulation, with care a good theodolite traverse can be carried over a considerable number of miles without any serious error.

In work of this kind several things must be borne in mind, of which one of importance is that, unless the ground is perfectly level, the measured distances will be too great and must be reduced to their horizontal values. Then the traverse should be checked wherever possible, and closed on to fixed points, in which case the angles and computed co-ordinates have to be corrected in order to make the closure. The diagram to the right (Fig. 27) shows a traverse that closes on its starting-point A.

Running a theodolite traverse through thick tropical forest is no light undertaking, and entails a vast amount of labour, as it frequently happens that a line has to be cleared through the forest for many miles.

Sometimes the country through which a traverse is run is not only thickly wooded but marshy and full of swamps, and not long ago a surveyor in West Africa told me that he had had to work for six weeks at a time in such a region, with water up to his knees, nearly pitch dark, and water continually dropping on him from the trees above. Add to this the pest of millions of mosquitoes and other insects, and numerous snakes, and you have a condition of things about as unpleasant as can be imagined.

In accurate traversing, distances are measured with a steel tape or chain; but, as you may suppose, this is often a difficult and lengthy business, and it frequently happens that some more rapid method has to be adopted.

For this purpose the tacheometer is of the greatest service. The ordinary tacheometer, in which two fixed wires, or points, are placed in the diaphragm of a telescope, for measuring distances directly by reading the number of feet and parts of a foot subtended between the two wires is well known; its principle is shown by Fig. 28.

There are many different kinds of tacheometers, but they all depend upon the same principle —that is, the obtaining of the distance by the measurement of the small angle subtended by a certain known space on a rod, such as 1 ft., 1 metre, etc. From the diagram it is clear that, taking AB as the rod and BC the known distance, AB : BC :: ab : bc, and the angle subtended by the rod AB will depend entirely upon the distance the rod is away.

A tacheometer of the ordinary kind is limited to comparatively short distances, such as 500 ft. or 600 ft. if any accuracy is required, since for long distances the figures and divisions become too indistinct; so for geographical surveying another form is generally used, called a subtense instrument, in which the wires, instead of being fixed, can be moved across the diaphragm, and made to cover the two target-like discs at the ends of a long rod, say 10 ft. in length, placed horizontal at right angles to the instrument.

The further the rod is away, the smaller will be the angle subtended by it. The angle is measured on the drums of the micrometer, and the distance corresponding to this found by referring to a table, or by simple computation.

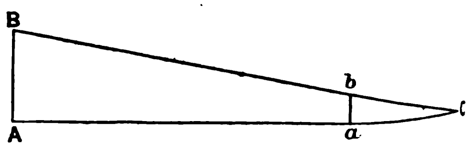

FIG. 28.—PRINCIPLE OF TACHEOMETER INSTRUMENT.

Fig. 29 is a view of the Indian Survey pattern subtense instrument.

Any good theodolite can be fitted with "stadia" wires, as they are called, in the diaphragm, for giving distances in the proportion

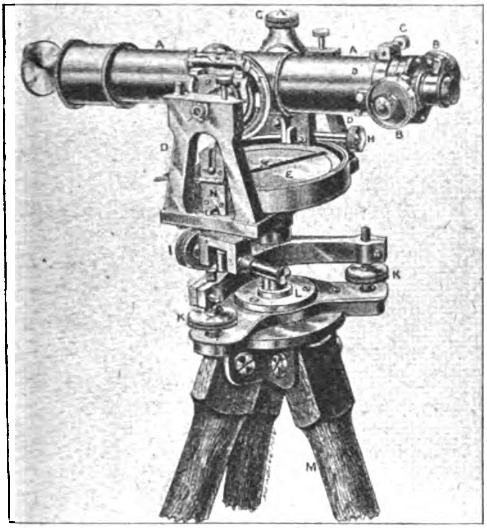

FIG. 29.—INDIAN SURVEY SUBTENSE INSTRUMENT.

of 1 in 100, or the small angle the rod subtends can be measured on the circles of the theodolite, if care is taken to provide checks and obtain means.

With tacheometers or subtense instruments of either of these patterns it is, of course, necessary for a man to go to the distant station and place a rod there, and when the stations are on the line of the traverse followed there is little difficulty about this, but there are many cases when it is most desirable that the distance of points to the left or right of the route, or any other inaccessible points should be fixed. For instance, in mountainous country intersected by deep gorges and passes, an instrument that really gives reliable distances to inaccessible visible points would be of the greatest assistance. A really good range-finder would answer the purpose, but the difficulty as a rule is that they are too approximate in their results. Occasionally a range-finder of the Barr and Stroud pattern has been carried, and found useful. There is also the distance-finder which I designed some years ago, a modification of which has been arranged for use in combination with a plane-table alidade.

The principle will be clear without much explanation. A rod $2\frac{1}{2}$ ft. to 3 ft. in length has at each end a telescope placed at right angles to the rod. Each telescope has a fixed horizontal and vertical wire in the diaphragm, and one of them has, in addition, another vertical wire that moves across the diaphragm by means of a micrometer screw, the divisions of which are marked on the micrometer drum. The rod is placed on the plane-table and levelled, and the left-hand telescope with the simple cross-wires accurately sighted on to the object of which the distance is required. On looking through the other telescope the same object will be seen to be slightly to the side of the centre, and this small amount is the angle subtended by the rod at the distance of the object. Errors are eliminated by taking the readings with the rod and telescope reversed, and accepting the mean as the true reading.

In open country, when there is not time to carry out a regular triangulation, it frequently happens that all a surveyor can do is to run a traverse and fix points by what is known as the latitude and azimuth method, and when the route follows a suitable direction, and other circumstances are favourable, this can be made to yield quite good results, although, of course, not so accurate as triangulation.

The principle of this method will perhaps be clear by referring to the diagram (Fig. 30). Let A and B be two stations on a route of which the latitudes have been obtained by astronomical observation, and let the azimuth or true bearing of B from A (= angle PAB) also be found from an observation. Then in the spherical triangle APB we have the co-latitudes AP and BP with the angle PAB given, to find the angle APB, the difference of longitude, and the length of the side AB, the distance between A and B.

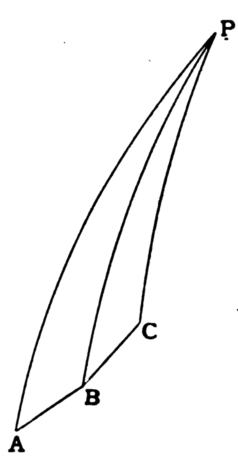

FIG. 30.—PRINCIPLE OF LATITUDE AND AZIMUTH TRAVERSE.

Having fixed B, the traverse can be continued to the next station, and so on, whilst theodolite horizontal angles can be obtained to side points along the route to fix their positions.

When the observations are carefully taken

and due allowance is made for the figure of the earth in the computation, the results are quite satisfactory for a first preliminary survey across a little-known region, and indeed much work has been done in Africa and elsewhere by this method.

So far the greater part of what has been said has had reference to the fixing of points, either by triangulation or on a traverse line; but it is clear that this alone does not make a map; and what a geographical surveyor has to do is to produce the best possible cartographical representation of the country, for which the definitely-fixed stations of a triangulation or traverse are but the points of control to which the topographical mapping may be adjusted. This is a matter of some importance, and one which should be borne in mind.

I could mention several instances in which surveyors have been supposed to carry out a geographical and topographical survey of a new region, but have spent nearly the whole of their time and money in attempting to fix points, forgetting altogether that the main object of their expedition was to produce a map showing the topography of the country.

It is in this representation of the leading topographical features that so many surveyors in the field come short. In fact, it is no easy matter to produce a proper generalisation of the leading characteristic features of a region, and not to give undue prominence to details because they appear large and important owing to the fact that they are close at hand. As is the case with many other things of the kind, to be a really good topographer a man has to be born with it in him, and if he has no natural aptitude for the work no amount of training will really make up for the deficiency, although he may be fairly good at other branches of the work.

There are several different ways of filling in topographical features in a survey, but whenever it can be used there is no doubt that there is nothing to equal the plane-table for rapid work on a geographical survey.

Although for many years past this instrument has been used in India and America, yet it was a long while before its merits were at all generally appreciated by the British surveyor.

I well remember the time, twenty-eight years ago now, when a young American engineer came to the Geographical Society in the days of my predecessor, full of the praises of the plane-table, and of the work that was being done with it in the United States. His astonishment at the little the possibilities of the instrument were appreciated in this country was great, and it was chiefly through the encouragement given by Sir Thomas Holdich and a few others interested, that he read a paper on the instrument before the Institute of Civil Engineers.

I have always looked upon this as marking an important epoch in the history of the use of the plane-table by British surveyors.

We are all doubtless familiar with the appearance and use of the plane-table in a general way, but there are some special features and improvements recently introduced that I should like to call attention to, as some of them are not so well known as they might be.

By way of refreshing your memories, I will make a few general remarks on the subject.

Plane-tabling is a graphic method of surveying by which, instead of measuring lengths and angles, and recording them in a book to be plotted afterwards, the map is produced on the spot, and grows gradually under the eye of the surveyor as his survey proceeds.

The plane-table consists, in its simplest form, of a board on a tripod stand, and a ruler, called an alidade, for sighting on to distant points. Now, suppose we wish to make a map of the district shown in the diagram (Fig. 31). To begin with, a base-line is measured and the plane-table set up at A, one end of this base-line. Then the alidade is sighted on to B, the other

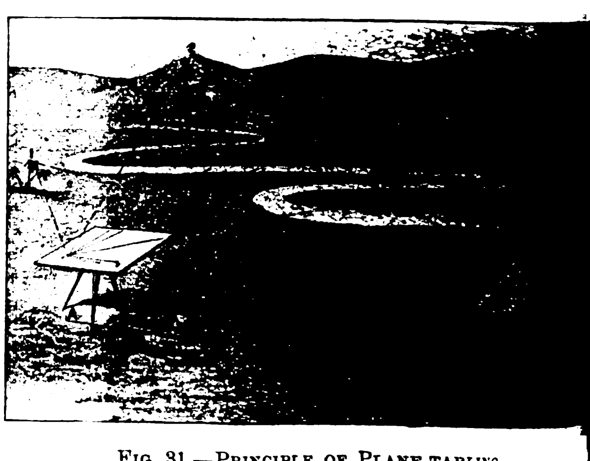

FIG. 31.—PRINCIPLE OF PLANE-TABLING.

end of the base, and a line drawn on the paper (mounted on the plane-table board) to represent the base-line to any suitable scale. With the alidade on the point A, all definite points in the country are sighted, and lines drawn towards them. Next the plane-table is moved to B, the other end of the base-line. The alidade is placed along the base-line and the plane-table and alidade together turned on to A. The board will now be oriented, as it is called—that is, placed with its sides in the same direction of the compass as they were at A. This orientation can also be made with the magnetic compass, if means are taken to test it. Now, having oriented the board, fresh rays are drawn to the same points to which rays were drawn at A, and you will see at once that the points of intersection of the lines drawn from B with those previously drawn from A will fix the points on the plane-table.

It is clear then that the plane-table can be used for making an independent survey; but with no means of checking the work and no points of control, serious error will be likely to creep in as the survey proceeds.

Where the plane-table is invaluable is in filling in the topographical features between points that have been previously fixed by triangulation. These points are first placed accurately on the plane-table, and then are used for the adjusting and filling in of the features of the ground, by methods known as resection and intersection. Practice is necessary, not only to learn what to show, but what to leave out; in fact, the surveyor has to grasp the whole, show the salient features, and not give undue prominence to mere minor details. Here a knowledge of geomorphology, as it is called, comes in—that is of the physical structure of the region to be surveyed—as this would teach a man what to expect, and keep him from making an impossible map.

The ordinary plane-table is a very simple affair, and any carpenter could construct one that would do quite well in an emergency, provided he could manage to make a board that would not alter its shape with damp and change of temperature. This is a serious difficulty in damp tropical climates, but has been got over by permanently mounting the paper on a sheet of aluminium, which is clamped on to the board when the survey is in progress, but taken off and placed in a suitable case when it is finished. This excellent arrangement was devised by the Ordnance Survey some years ago, and has been found most useful.

Instead of an ordinary alidade, or sighting ruler, it is a decided advantage to have one with a telescope, specially when long-distance points are concerned, and many such have been designed. These are, however, often much too heavy and bulky for general use, besides being awkward to pack in a case.

To obviate these difficulties, some years ago I designed the folding telescopic alidade. The pedestal of the telescope is hinged to the ruler, and the whole thing can be quickly folded up and placed in a small case when not in use. There is a vertical arc for giving angles of elevation and depression from which the difference of height between points can be computed, and to render this operation simpler the tangents of the angles are engraved on the arcs as well as the degrees and minutes. This folding telescopic alidade has been found of considerable service, and an elaboration of it is now generally used in the colonial surveys in Africa.

In all surveying the question of the height above sea-level, or the relative heights of points, is most important; for a place is not fixed by knowing only its horizontal position. It is necessary to bear in mind, too, that heights in lowlands and valleys are as important as those of peaks or high points of land, in order to give a representation of the relief of a country. This fact is frequently overlooked by inexperienced surveyors.

The most accurate method of determining the differences of height is by levelling either with a dumpy level, or, better still, by one of the improved levels that have been introduced in recent years, such as the Zeiss or the United States Coast Survey "Precise" level, in which it is possible to see the bubble at the same time as the wires, object, and staff reading.

The accuracy of modern levelling is certainly remarkable, and Colonel Close states in his "Notes on the Geodesy of the British Isles," that in the recent lines of levels run by the Ordnance Survey the probable error in 100 miles was found to be only a quarter of an inch.

It frequently happens that levelling is out of the question, since time does not admit of such a lengthy process, and all that can be done under the circumstances is to obtain heights by theodolite vertical angles. This method, when the distances are accurate and the necessary corrections are made for curvature and refraction, gives very fair results, and if reciprocal angles are observed, relative heights between two places will come out to within 3 ft. or 4 ft. of the

truth, and closer still sometimes, if the points are clearly visible.

When no more accurate method is possible for absolute height above sea-level the geographical surveyor has to depend upon barometric and hypsometric readings, which are far less reliable and may be as much as 50 or 150 feet in error, according to circumstances, and the accuracy with which the reference station reading is known.

The most reliable of the instruments for obtaining heights by methods depending upon the change in atmospheric pressure is the mercurial barometer, which may give results much nearer than those stated, perhaps not more than 10 ft. in error; but this is difficult to carry on an expedition through rough country as it is very liable to be broken, so an aneroid usually has to take its place, which is the least reliable of all. From experience I have found

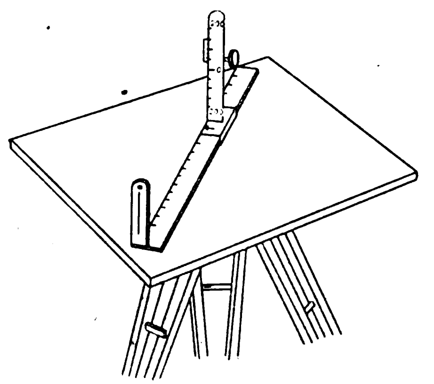

FIG. 32.—NEW PLANE-TABLE CLINOMETER.

that the aneroid, unless checked by some means, is almost useless for great differences of height, and seems to have no constant error.

The boiling-point thermometer may be as much as 100 ft. to 150 ft. out; but this, as a rule, remains fairly constant, even at great altitudes.

The Indian Survey clinometer is a good and serviceable little instrument for use with a plane-table. In appearance it is much like a short plane-table alidade. The eye is placed at a small hole in the sight near the eye, and at the point where the distant hill-top, or whatever the object may be, comes in line with the scale on the further vertical sight, will be found the tangent of the elevation or depression angle. The distance taken from the scale of the map multiplied by this tangent is the difference of height between the surveyor's position and the distant point.

The computation is simple, and does not take very long; yet if there are many points it would be a considerable advantage and a decided saving in time, to have some kind of clinometer that gives heights in feet or metres right off at a glance without any computation whatever. I have lately designed such a clinometer which is shown in Fig. 32. It can be made to suit any scale, or interchangeable scales can be fitted to the same instrument. In general appearance this instrument represents the ordinary plane-table alidade; but it differs in this respect, that the further vertical sight is made to slide along the alidade and so can be set on to the position indicating the point of which the height is required on the map; while the near sight is placed on the surveyor's station. When this is done, the instrument truly levelled, and the movable wire made to intersect the object, the difference of height above or below the observer's station is read directly off the scale without any computation.

In geographical surveying, as in many other things in this world, a man has to do the best he can under the circumstances in which he is placed, and there is nothing that tests one's resources more than this work, nor is there anything that requires more experience to do well.

In unexplored regions, or those that are only partially mapped, it still more frequently than not happens that all that can be done is to make a rapid route traverse with a prismatic compass or sketching-board, and adjust it where possible by astronomical observations for latitude and differences of longitude. Distances are usually obtained by time and estimated rate; and with practice better results can be gained by this method than might be expected.

So much depends upon the character of the country and the man himself, that it is difficult to say what error may be expected; but I have frequently been surprised at the degree of accuracy it is possible to obtain even by this rough method. In a fairly level country it is not unusual to find that the error does not exceed 4 or 5 per cent. of the whole route, while in rugged mountainous country it is likely to be much more, probably 8 per cent. Over long distances, plus and minus errors have a remarkable tendency to balance one another.

I have not, so far, referred to photographic surveying, and I propose now to say a few words on the subject, without attempting to go at all into detail.

For years past the subject has received considerable attention, and recently a great deal

has been written about it. There can be no doubt that under special conditions the method is of considerable service in geographical surveying; but its use is limited, and it has not proved of such general value as was once supposed that it would. It will never supersede the ordinary exact methods, and the most that can be said of it for geographical surveying, at any rate, is that it at times constitutes an important and rapid means of filling in topographical features. In rugged mountainous regions, difficult of access, the method has proved itself decidedly useful, and much of the Rocky Mountain districts of Canada has been mapped by it, as also have certain districts of Central Asia, the Himalayas and other mountainous regions. It is of little service in a country without well-defined features; and since the ground is not, as a rule, visited, the mapping is necessarily incomplete.

Ordinary photographic surveying consists of taking photographs at the two ends of a measured base-line, or at several known stations, and then, with these photographs properly oriented, fixing upon the map the positions of the unknown points shown on the photographs by intersection. This really amounts to plane-tabling from photographs in a room instead of from the points themselves in the country; and it will be understood at once that the chances of error are far greater, although with care quite good results have been obtained.

Many photo-theodolites, as they are called, have been devised for taking the views. The Bridges-Lee photo-theodolite* is certainly one of the best, and a photograph taken with it shows the horizontal and central vertical lines, as well as the scale of degrees of horizontal angles and the compass-bearing on the top.

Photographic surveying has been improved by the introduction of what is known as the stereo-photo method, which was described by Lieut. F. V. Thompson, R.E., in the *Geographical Journal* for May, 1908, and further by myself in the same journal for April, 1913.

Briefly this consists of taking photographs in the same vertical plane, at a measured distance apart, and viewing the negatives or positives taken from them in a special form of stereoscope. The eye-pieces of the stereoscope are provided with exactly similar indices, which can be made to combine stereoscopically with any given point on the view by increasing or decreasing the distance between the slides holding the photographs. The amount of separation required for the stereoscopic combination gives the distance of the point from the plane in which the plates are exposed, and the angular measurement round the horizon of any point, as well as its vertical elevation, can also be obtained from the scales, so that the point is definitely fixed.

The astronomical observations usually taken by a geographical surveyor consist of meridian and circummeridian altitudes of north and south stars, or of the sun, for latitude, and sets of east and west stars, or the sun, for time, rating the chronometer, differences of longitude and observations for azimuth. Occasionally other observations are taken, such as equal altitudes, double altitudes, and occultations of stars by the moon. These are all explained in Colonel Close's "Text Book of Topographical and Geographical Surveying," the Royal Geographical Society's "Hints to Travellers," and other works.

The method of fixing a position and finding time and azimuth by three or more equal altitudes is now being used a good deal with excellent results, and the French have brought out a special instrument, called the "Astrolabe à Prisme" for observing the altitudes; but these can, of course, be taken with a transit theodolite set at a fixed altitude angle, with which several surveyors have obtained results that compare very favourably with those taken with this special instrument. However, the Astrolabe à Prisme is an interesting instrument, and is stated by those who have used it to be superior to the theodolite for the purpose. Those who are interested will find a description of it in my paper in the *Geographical Journal* for March, 1913, and a more detailed account in the paper by Colonel Woodroffe in the number for May, 1916.

The instrument consists, in the main, of a telescope in front of which is fixed a prism, with the faces cut at an angle of 60°, and a flat circular dish of mercury placed below the prism, so that rays of light passing from a star are reflected from the mercury on the lower face of the prism, and thence down the telescope to the eye, while other rays from the same star fall directly on to the upper surface of the prism, and, like the former, pass down the telescope to the eye. Thus, when the star attains an altitude of exactly 60° its two images are seen to coincide, and when this takes place the time is noted. Equal altitude observations of a number of stars, at least three, on different sides of the horizon, are taken, and from these the latitude, local time, and azimuth can be computed.

* The apparatus was described by Mr. Bridges-Lee in a paper read before the Royal Society of Arts in 1902 (*Journal*, Vol. L. pp. 493-508).

With a 5-in. micrometer-theodolite it is quite possible to obtain latitudes to within 2" or 3" of the truth, by north and south stars, and if a mean of several pairs is taken the result may be nearer still; but it should be remembered that there is always an uncertainty of a few seconds in any astronomically-determined latitude, due to the uncertain effect of gravity and deflection of the plumb-line or local attraction, as it is called.

It is easy enough to find latitude and azimuth within the limits of accuracy required for geographical surveying. Local mean time also presents very little difficulty, but longitude is quite another matter, for although this is also quite easy in theory the practical difficulties are considerable. There is no difficulty about taking the observations for finding the time at the place where the surveyor is, but longitude is the difference of time between two places, that of surveyor and of some initial meridian, and it is in obtaining the latter that the difficulty comes in. At sea it is simple enough, for the navigator takes five or more carefully-rated chronometers, which give him his Greenwich mean time, but on land during rough travelling it is quite another matter. Occultations, lunar distances, and all other methods that depend upon the moon's motion are far too approximate for modern requirements—at least, all except the occultation method, which is still occasionally resorted to. What it has really come to in recent years in route traversing is that no attempt is made to carry Greenwich mean time, but differences of longitude are obtained by theodolite observations for local mean time at the different places and rate of the watch. But then the difficulty again arises of obtaining a reliable and steady rate for the watch, which is not at all easy in travelling over rough country.

In recent years wireless telegraphy has come to our aid in this matter, and, as I have stated elsewhere, has given excellent results. Wireless signals are sent from some distant transmitting station, and the surveyor carries a portable receiving apparatus about with him—which weighs only a few pounds, and is comparatively inexpensive. With this he receives the signals, and the difference between the local mean time he finds from his theodolite observations, and the time of the place from which the wireless signals are sent, obtained by his receiving apparatus, is the difference of longitude between the two places.

One of the most recent examples of the use of wireless in obtaining longitude is that of Captain Edwards, R.N.R., of the Bolivia-Peru Boundary Survey, and another is that of the Italian expedition of Dr. de Filippi in the Himalayas, 1913-14, both of which have been described in the *Geographical Journal*.

In conclusion, I desire to express my thanks to the Royal Geographical Society for the use of many of the blocks which illustrate these lectures.

OBITUARY.

COLONEL JOHN ORD HASTED.—Colonel John Ord Hasted, late of the Royal (Madras) Engineers, formerly chief engineer of the Public Works Department, Madras, and Deputy Chief Engineering Inspector of the Local Government Board, Whitehall, has died at his residence, Brook House, Rickinghall, Suffolk, at the age of eighty-one years. The son of the Rev. H. J. Hasted, of Sproughton, Suffolk, he obtained a commission in the Madras Engineers in 1853. He served in the Public Works Department, Madras, from 1856 successively as assistant, executive, and superintending engineer, and in 1884 was appointed chief engineer for irrigation and joint secretary to the Government, and in 1886 secretary in the general and buildings and roads branches. Colonel Hasted retired in 1890, and was elected a Fellow of Madras University in 1883. He was elected a member of the Royal Society of Arts in 1891, and in the same year he read a paper before the Indian Section on "The Periar Irrigation Project, Madras Presidency."

GENERAL NOTE.

TESTING AND USE OF MAGNETIC MATERIALS.—The United States Bureau of Standards has published a circular on "Magnetic Testing" for the benefit of engineers and others who are interested in the testing and use of magnetic materials. The circular gives definitions of the fundamental magnetic quantities ordinarily employed in technical work, outlines the scope and describes the magnetic methods employed at the Bureau of Standards, and discusses the type of data required in engineering work. Typical data and curves are given which may be considered characteristic of the common magnetic materials, and a table of magnetic susceptibility is given for the elements. The circular also considers the more important empirical formulae which may be used to represent the behaviour of magnetic materials under different conditions. A list is given of the publications of the Bureau on magnetic subjects. Copies of the circular (No. 17) may be obtained by interested persons from the Bureau of Standards, Washington, D.C.

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FRIDAY, OCTOBER 6, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

VIBRATIONS, WAVES AND RESONANCE.

By J. Erskine-Murray, D.Sc., F.R.S.E., M.I.E.E.

Lecture I.—Delivered May 1*st*, 1916.

Vibrations.

The extent of the field covered by the subject of these lectures is so vast that it would be quite impossible for me to describe in detail even one of the many types of periodic motions which exist. I shall not attempt to do so, but shall try to explain to you the general principles underlying all wave motions, and describe only such particular cases as appear to illustrate these principles most simply and directly. You will understand, therefore, that when I have demonstrated any property of vibrations or wave motions by experiment or otherwise, the property is in general a quality of all such motions whether material or electrical, and, if the nature of the vibrator or of the medium in which the wave motion takes place be specified, the results obtained in the demonstration are applicable, *mutatis mutandis*, in all cases. I shall, in fact, treat the subject from the point of view of natural philosophy, which deals with the laws of the natural world, rather than that of physics, which is mainly concerned with the description of phenomena.

A vibration is a to-and-fro motion. It is called periodic if it is repeated in equal successive periods of time, and this even if the repetitions are only similar in character though not in magnitude. The *period* of a vibration is, therefore, the time of one complete vibration—there and back again—and its *frequency* is the number of complete vibrations in one unit of time.

The frequencies of the vibrations which concern humanity range from about thirty million-million-million per second in the case of the gamma rays given out by a radio-active substance, to one in twenty-six thousand years, which is the frequency of the motion known as the precession of the equinoxes. Briefly, the result of this latter is that thirteen thousand years hence midwinter will be in June and midsummer in December in the northern hemisphere. And here it suggests itself that if we can "save" an hour of daylight by "merely turning on the clock," might we not "save" a summer by merely altering the calendar?

Between these limits of frequency, the greater of which is twenty-five million-million-million-million-million times the less, lie the frequencies of motions with which we have to deal. These run through X-rays; ultra violet and visible light; heat waves; waves which are recognisable by what are known as electrical actions and are therefore called electric waves, whether fast or slow, conducted or free; the vibrations of sound; of the heart and respiration; of machinery and structures; of ocean waves and tides, and of the earth itself—a wonderful list, almost every item of which is present with us at all times.

It is hardly astonishing that rhythmic motions should be of so much interest to humanity, for the life of each of us is wholly dependent on two vibrations. If the heart or lungs cease their regular periodic motions we cease to live, and even small changes of frequency or amplitude may be of serious moment. Music, dancing, the beat of the drum and the regular tramp of marching troops are all pleasant, for our hearts respond to the rhythmic stimulus, and even "carriage exercise," with its comparatively gentle vibrations, is often of value to health.

Although the variety is apparently so great, there are in reality only two kinds of physical vibration—one in which the thing moved is electric, and the other in which it is ordinary, or

ponderable, matter. In both cases the energy associated with the material moved is converted from energy of stress into energy of motion, and back again to energy of stress twice in each period of the vibration. In this pendulum, for instance, the energy of the gravitational stress between the bob and the world is converted into kinetic energy as the bob swings down towards the world, and is reconverted into energy of stress as it rises again on the other side. On the return journey, completing the period, the same conversion and reversion takes place. In these other oscillators which I show you the stress is that of a strained elastic solid or fluid, but the cycle of energy and motional changes is still the same.

In all cases the primary condition for the possibility of a vibration is that the body or system, to use a more general term, must have a position of stable equilibrium—that is to say, one from which to move it in any direction requires that the work done on it should be converted into energy of stress. The pendulum, for instance, is stable in its lowest position, and an electric vibrator when it has uniform potential throughout. There is a secondary condition which must be fulfilled if the vibration is to be periodic, and this is that the energy of motion must not all be converted into molecular motions, by friction or otherwise, by the time the system first reaches its position of equilibrium. If, for instance, the pendulum be moving in a sticky fluid such as treacle, it may come quite to rest on its first arrival at the lowest point of its course, or rather it may take an infinite time to get there, all its energy of motion being used up in molecular friction in the liquid and so converted into heat.

I have another vibrator here in which gravity plays no part, since its motion is entirely in a horizontal plane, neither rising nor falling. It consists of a cast-iron wheel threaded firmly on to a vertical strip of clock spring, the latter being fixed, at its upper and lower ends, to a rigid frame. If I turn the wheel and let go, it swings round to its position of equilibrium, passes it, stops and reverses its motion, and continues to rotate to and fro with slowly decreasing motions. Here the potential energy of the elastic stress in the steel strip, which is twisted when the wheel is turned, is converted into kinetic energy of the rotating wheel in the first quarter period, reconverted into potential in the second quarter, and so on.

All the while, however, some small proportion of the energy is being lost in friction, or rather is being converted into the energy of molecular vibrations in heating the steel strip and the surrounding air. This is so entirely general a condition of all physical motions that one may state it as a principle, thus: In every physical motion of greater than molecular dimensions, whether of ponderable matter or of electricity, there is a continuous conversion of energy into the energy of molecular vibrations. Thus all friction produces heat, and no motion of real matter is perfectly frictionless nor is any electric circuit entirely without resistance. If no other proof existed of the molecular nature of matter we should still have one here which would be almost incontrovertible, for the vibrators which produce short waves must themselves be small.

Returning to the torsional vibrator, you can see that its rate of vibration depends mainly on its inertia and on the restoring force of the spring, for by placing an additional mass on the wheel the rate of vibration becomes visibly slower, while the same result is observed if a weaker spring is used. Frictional resistance also slows the motion, but, unlike added inertia, it produces the further effect of rapidly damping it out altogether.

Three factors such as these determine the nature of all free vibrations whether mechanical or electrical. Thus, in an electrical vibrator, having no mechanical motion, the electric stress in the dielectric produces a current in the conductor, which in turn generates magnetic force around it, thus delaying the growth of the current, but temporarily maintaining it when grown, just as inertia does in the torsional vibrator. Electrical resistance, like friction, retards the motion throughout, and finally converts into heat all the energy that has not been radiated as electric waves.

We may make some sort of mental picture of what goes on in an electric oscillator during its action by translating into terms of ordinary materials the electrical quantities concerned. A non-conductor or dielectric, for instance, is equivalent to an elastic but incompressible jelly or mass of indiarubber, while a conductor is a cavity in the jelly filled with an incompressible liquid. The conducting plates of a condenser may thus be represented by two cavities filled with water in a great mass of jelly and separated from one another only by a thin wall. I say a great mass because the air surrounding them is like the glass between the plates, a non-conductor. The plates are, therefore, two isolated cavities filled with water in a mass of jelly. Suppose now that I drive a small tunnel, also

filled with water, from one cavity to the other, and in this tunnel place a pump or piston by means of which I can take water from the one and drive it into the other. As I do so, taking water from the left-hand cavity and driving it into the right-hand one, I cause the latter to swell and the former to contract, and since the thin wall of jelly between the cavities has little rigidity, it is here that the greatest swelling and contraction take place. The wall bulges towards the left-hand cavity, and of course the jelly forming it is strained. Now the wall represents the dielectric of the condenser, the increase of volume of the right-hand cavity is the positive charge, and the equal decrease of volume of the left hand is the negative charge on the other plate of the condenser. This picture is correct in two important respects at least; firstly, it shows that the amount of charge which a condenser will hold is not, like the capacity of a pint pot, simply defined by its dimensions, but is also dependent on the pressure or voltage between its plates and on the stiffness of the dielectric; the electrical capacity has, therefore, to be defined as the charge at unit electrical pressure; secondly, it shows the potential energy stored, not in the charges themselves, but in the elastic stress in the dielectric. (See Fig. 1.)

If now the piston in the tunnel connecting the cavities be suddenly annihilated, the tension in the bulging wall will tend to drive the excess liquid in the right-hand cavity back through the tunnel towards the left hand, and this pressure will continue to act until the elastic strain is entirely relaxed and the cavities return to their original sizes. At this moment, however, the water will be flowing rapidly through the tunnel from right to left, and, although there is no longer a pressure driving it, it will continue to do so on account of its inertia even after the position of equilibrium has been passed. Thus the left-hand cavity will be charged to a high or positive pressure and a negative charge will be produced in the right-hand one. When all the energy of motion of the water has been converted into potential energy in the elastic wall, now bulging towards the right, the motion will cease, the flow will reverse, and the operation will recommence in the opposite direction. These reversals of flow will continue, though becoming gradually less and less, until all the energy originally stored in the stretched wall has been converted into heat through friction or radiated throughout the mass of jelly as elastic waves.

This picture apparently fails in one respect only to represent an electric oscillation, and that is in the representation of the inductance of the circuit by the inertia of the water. In the electric case the kinetic energy of the current is not in the conductor itself, but is located as magnetic stress in the medium surrounding it, while inertia we usually think of as a property located entirely in the mass itself. Who knows, however, that this is so? We cannot appreciate inertia in a single body by itself. Even if we consider a solitary body in rotation we have to imagine it to be divided into two parts between which there is a stress before we recognise its inertia. Thus there must always be two bodies between which the force can act by which we know of the existence of mass, and if there must

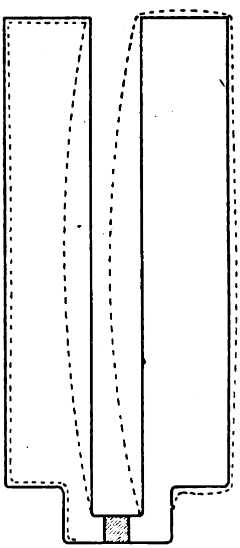

Fig. 1.—Model Condenser Circuit.

be two bodies we at once realise that the property which we supposed was wholly located in the body may in reality be just as likely a property of the medium surrounding them such that their relative motion through it causes a storage of energy in it and not solely in the bodies themselves. If so, our picture may be more complete than it at first appears; but in any case it is a good and serviceable representation, equally true to nature whatever theory of the ultimate constitution of electricity may be adopted.

The vibrations which I have so far shown you have been simple and more or less exactly of the type known as "simple harmonic." Such vibrations, however, are not as common in nature as the more complex kinds; but,

luckily for us, Fourier discovered that every complex vibration could be analysed into a group of simple harmonic ones, and on the other hand, that by superposing properly chosen simple vibrations on one another any desired complex vibration could be built up. The simple harmonic or sine wave type of vibration is, therefore, not only simple, but is also fundamental. The vibrator which I now show you in motion consists of two elements, each being formed by a helical spring with a weight attached to it (Fig. 2). If the two are hung up in series from a firm support, that is to say, in the order counting downwards, of support, spring, weight,

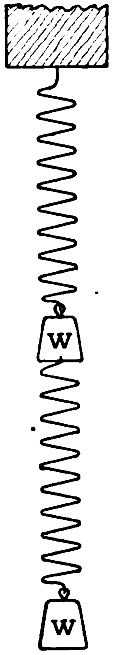

FIG. 2.—COMPLEX VIBRATOR.

spring, weight, you see that by giving impulses in opposite directions to the upper and lower weights we obtain a curiously jerky, complex motion of the lower weight as it rises and falls. The fact is that we have superposed the vibrations of the parts on the slower vibration of the system as a whole, and the movement of the lower weight, though still periodic, is no longer a simple harmonic vibration.

Complex vibrations of this type are most directly interesting to every human being, though he or she may not be aware of it, since it is through their character, and in no other way, that speech is articulate and that one speech sound is distinguishable from another. The sound "oo," for instance, is merely a smooth vibration, while "o" is a compound of the same sound with a vibration twice as fast, i.e. the octave above. "Ah" contains also the third harmonic, or fifth above the octave, and "ee" is a still more jerky vibration. All other articulate sounds are defined in the same way, each by its component simple vibrations, and each can be represented by a single wavy line having a definite character of its own. If the pitch on which the sound is spoken is higher or lower, the rate of vibration becomes greater or less, but its character is unchanged.

I move my hand smoothly to and fro. If I could do so at something over thirty times per second you would hear the sound "oo": I move it again to and fro, but this time in a series of small jerks. If it were fast enough you would hear the sound "ee." Every sound in every language could be produced in this way, if one could only move one's hand sufficiently rapidly and give its motion exactly the proper form.

About fourteen years ago, when lecturing on physics in University College, Nottingham, I constructed a little instrument which will show you the actual forms of the vibrations of various sounds. A piece of thin sheet indiarubber is stretched over the end of a short hollow cylinder about 2 in. in diameter. On the centre of the indiarubber a small circle of paper is stuck in order to give a little greater stiffness, and to the paper is attached, by a small indiarubber hinge, a rod of wood about 5 mm. long and 1 mm. or less in diameter. The top of the rod is hinged to one edge of a little mirror, which lies parallel to the membrane and is mounted on a fine needle pivoted at both ends and borne by supports attached to the cylinder or mouthpiece. Holding this little instrument, which I have named the phonoscope, in my hand, I direct it so that a spot of light is reflected from its mirror on to the screen. If I speak to the membrane it vibrates and the spot of light becomes a short vertical line, and if at the same time I turn the phonoscope to and fro this line is stretched out into a beautiful wavy curve, which changes its form with every inflection of the voice. You can see the different characters of the vowel sounds—the large explosive wave of the letter "p," and the curious beating trill of the letter "r." You can also see that the number of vibrations per second is greater in a high than in a low note, but that mere change of pitch does not alter the character. If I were to play different musical instruments to the phonoscope you would learn

to recognise that the timbre of each is in reality defined only by the character of its vibration curve; that the flute gives a smooth wave, while that of the violin is complex and full of higher harmonics. Even the combined sounds of a whole orchestra make up but one wave curve—a very complex one, but still quite definite and capable of analysis.

Fascinating as is the study of the forms of musical and articulate sounds, we cannot at present spend more time on it, but must get on to other types of vibration. The earth itself, for instance, is in a constant state of tremor, sometimes more and sometimes less, but never quite at rest. Its vibrations are usually too slow to be audible, but occasionally there are rumbling sounds and dull thuds such as I heard during a small earthquake in the Midlands some years ago. It was like the passage of several heavy traction engines over a causewayed street close by. Quite thirty years ago I was taken to see an earthquake recorder in the little town of Comrie in Perthshire. It was a very simple affair, just a thin lath of wood held in a horizontal position by a fixture at one end, and placed so that the maximum movement of the free end was recorded by the displacement of a straw pointer on a dial. If the earth rose suddenly, the fixed end of the lath and the dial both rose with it, but the free end lagged behind and pushed the straw round to a new position, where it stayed and thus gave a record of the magnitude of the shock. The instrument was, I think, devised by the local baker. Present-day seismographs depend on the same or similar principles, but have been made to give continuous records, instead of merely an indication of the maximum vibration. A large mass is fixed to the end of a spring or forms the bob of a nearly unstable pendulum. As the earth shakes, the bob, owing to its great inertia, remains almost unmoved and the relative motion of earth and bob is recorded photographically, or if the ground is tilted up the pendulum comes over and shows the slope.

I have here a rough model built on the same principle, which will show you the action. A strip of metal is fixed horizontally at one end, and from its other end two short parallel threads run to adjacent fixed points on the table. A small mirror is stuck on to the threads and reflects a beam of light on to the ceiling. If I jump on the floor some yards away, you notice that the spot of light vibrates, showing the transmission of the vibration through floor and lecture table to the seismometer.

The reason why the early seismometer was found at Comrie is that a great geological fault, which stretches from the Firth of Clyde to near Aberdeen, runs through the town. On the south-eastern side of the fault lie the comparatively modern carboniferous strata, while to the north-west of it the ancient Silurian rocks are thrust up thousands of feet; the fault is in fact a great crack or discontinuity in the earth's crust. Now, as the earth contracts its crust becomes strained, and from time to time the stress causes a sudden, though small, slip at the fault itself, one side rising and the other falling to accommodate themselves to the growing pressure. This is an earthquake, and the vibrations caused by the sudden motion spread out through the neighbouring rocks.

To show you how frequently these tremblings occur, I may tell you a story told me by the late Professor Milne some years ago. It was at the time when the Psychical Research Society was investigating household ghosts, and, as you know, there are many of these in old Scottish houses. Often nothing is seen, but curious noises are heard, locked doors open, and the dwellers in the houses are aware that something uncanny is happening. The Society asked Professor Milne to take one of his seismographs to various houses, and, as a result, it was proved that in several cases the ghost was in fact a seismic tremor, too slight to be recognised as an earthquake, but quite sufficient to do the work of the ghost.

Volcanic explosions sometimes produce extraordinarily powerful vibrations. When the mountain of Krakatoa, in the East Indies, was rent to pieces by the steam pressure in the cavities below its crater, the pressure wave produced in the air was so great that it was heard as a loud sound at a distance of more than fifteen hundred miles, and travelled eight times round the earth before it became too weak to affect a registering barometer. The energy and suddenness of the explosion must have been very great, for although the firing of great guns has been heard in the present war up to distances of more than three hundred miles, it is equally true that thunder rarely carries as much as twenty.

Instruments have now been constructed which register the vibrations of all kinds of structures, and many interesting results have been obtained by using them in buildings and on ships and railway trains. It has been shown, for instance, that short and sharp vibrations of ten or more to the second are much more exhausting to the

human frame than those of longer and smoother period. The natural vibration of a torpedo-boat destroyer is about three per second, while an old third-class carriage makes twenty or thirty very irregular jerks in the same time.

All the vibrations which we have considered so far have had what is called a "static" restoring force; in some cases this has been gravitational, and in others elastic or electric. Now, however, I shall show you two cases in which this restoring force is actually and obviously due to motion. Here is a small gyrostat—just a heavy wheel pivoted inside a ring-shaped frame. I cause it to spin rapidly and set it on the table. You notice that it stands up, supporting itself on the edge of the ring, apparently in defiance of gravity. It appears to be held up, as if in virtue of its motion] it had a grip on something that we cannot see. I strike it, and it vibrates as if supported by some intangible elastic solid. Here the restoring force is not static, but is due to the motion of the mass constituting the wheel. May it be that, as I suggested when describing the oscillations of the liquid in a model electric condenser, the rotation of the wheel does actually give it a grip on some all-pervading medium? If so, we should expect that two rotating bodies would react upon one another across space in virtue of their rotations—a notion which may be proved or disproved by experiment, or perhaps by deductions from planetary astronomy.

One most interesting way of looking at gyrostatic phenomena is to consider them in relation to gravitational force. Thus, for instance, a spinning-top when at rest lies with its centre of gravity as low as possible, but when spinning it rises till its centre of gravity is as high as it can get. If I strike the top lightly when spinning it nods, but rises again to its steady position; its rotation has thus changed a position of unstable equilibrium into one of stable equilibrium about which it can vibrate. The spinning-top has thus the curious property that in a field of gravitational force it places itself so that the gravitational potential energy is a maximum, the line from its point of support through its centre of gravity being parallel to the gravitational force and directed away from the earth. It would be very interesting to know whether similar effects are obtainable in uniform fields of force other than gravitational — whether, for instance, an electric or magnetic gyrostat could be constructed which would tend to get into a position of *maximum* potential energy when rotating in an electric or magnetic field.

Now I shall show you a vibrator which really is very strange, for it consists merely of air in air, and yet is a distinct entity, a body capable of vibration, and can travel through the atmosphere of which it forms, and yet does not form a part. Here is a large box full of air, which has in front an elliptical opening and at the back a hinged flap like a bellows. Mixed with the air, to make its motion visible, there is some smoke, or the cloud of fine crystals obtained by mixing gaseous hydrochloric acid and ammonia. I slap the back of the box, and a puff comes out at the front which quickly takes shape as a definite and cleanly formed ring, not circular, but changing rapidly from an ellipse with its greatest length vertical to one which has its greatest length in a horizontal direction, and vice versa. Out of air I have in fact created a vibrator having apparently all the properties of an elastic solid. If I could make it vibrate fast enough you would hear a musical tone—a sound produced by an unenclosed mass of air vibrating in air.

It has occurred to me since first I saw these rings produced in Lord Kelvin's class-room that this experiment may not unlikely have been the origin of his vortex theory of matter. A vortex ring when circular is beautiful, but an elliptical one is so obviously a material thing with elastic properties of its own that, after seeing it, the temptation to make use of it as a possible ultimate basis for a theory of matter must have been irresistible to a mind like Kelvin's.

CHINESE METHODS OF SALT PRODUCTION.

In the course of a report the United States Consul-General at Hankow says that the production of salt is controlled in all parts of China by the Government, although actually in the hands of private producers. There is only one producing centre of salt of great importance in the Hankow consular district. That is Ying Cheng Hsien in Hupeh, producing an estimated quantity of 15,000 tons per annum. Ying Cheng lies north of the Siang River, bordering on a number of shallow lakes and waterways which provide transportation to the Siang River. It is about 25 miles west of the Pekin-Hankow railway station of Siaokan. The district is 13 by 6 miles, and has produced gypsum (selenite) for some 200 years. The producing strata lie from 400 to 900 ft. below the surface, and are reached by shafts sunk vertically. There are 190 pits, of which only twelve are worked for brine in the manufacture of salt. The plan is to quarry the gypsum and to work each pit for this

article for a period of two or three years, and then close for a year.

Brine is produced by natural leakage or by pouring water into the galleries which probably follow the inclined gypsum strata. Salt (sodium chloride), being a common accompaniment of gypsum deposits, appears to be either in solution as brine in the pores of soft rock which lie in layers on either side of the strata or as natural salt. The saline substance is dissolved from the rock laid bare by the quarrying, and after the pit has been closed for a year a sufficient quantity of brine is obtained for working from one to five months, when the gypsum is again worked and the former process repeated.

The brine is brought to the surface by a windlass and rope, in wooden buckets, and is poured at the pit mouth into large wooden reservoirs sunk into the ground. From the reservoirs it is emptied by buckets into mat-covered wooden troughs led across country a few hundred yards to the furnaces, where the brine is boiled in pans. The boiling pans are arranged in batteries of three to five furnaces, and are set up under sheds having tiled roofs and open at the sides. Boiler-plate caldrons of foreign manufacture, 3 ft. in diameter and 1½ ft. deep, are arranged in sets of nine over each brick furnace.

These furnaces are sunk in the ground so that the level of each caldron is just above the surface. Underneath is a fire box, passing below each of the nine iron caldrons in succession to two brick chimneys at the end of the furnace. The fuel used is slack coal procured in the vicinity of Hankow.

DISTRIBUTION TO CONSUMERS BY SMALL DEALERS.

The brine, stored in large wooden reservoirs, is ladled by coolies into the caldrons, which boil so incessantly that the water is rapidly evaporated. The salt gradually precipitates as the density of the liquid becomes greater and is dipped into split-bamboo baskets. The distribution of the salt thus produced is made to the consuming areas by small dealers from two baskets carrying about 50 lb. slung at either end of the pole. The salt produced is snow white, very fine, crystallised, and of good flavour, though described as having a bitter taste, due probably to excessive magnesium.

The 190 active gypsum pits are scattered over an area of 80 square miles. Each furnace in the manufacture of salt is limited to nine iron caldrons, and each of these furnaces has a capacity of production of 32,000 lb. in 24 hours.

A classification of the sources of production in other parts of China may be made as follows:—

LOCATED ALL ALONG CHINA'S SEA COAST.

The Huaipei saltworks are typical of those located all along China's sea coast. They produced more than 500,000 yin of 440 catties each (catty = 1·4 lb.) per annum. Away from the sea coast there are many factories for the manufacture of salt from brine drawn from wells. The product is of good colour and edible, resulting from the condensation by solar heat of this subterranean brine.

The Tientsin (Changlu) arrangements for the production of salt are as follows: There are three large groups of saltworks, one on each bank of the Peiho River and one on the Peitang River. These localities are large mud flats commanded by the tides, and are very favourable for salt manufacture. The levels permit brine to be brought from the sea to the works by flow at spring tides, in canals or channels dug for the purpose. When the brine canals are full, temporary dams prevent any over supply, either of brine from the sea or fresh water from the rivers, and keep the brine in the canals at the required level. The brine is raised from the brine canals into the reservoirs and evaporation pans by an ingenious system of lifts operated by wind sails.

SEVERAL PROVINCES PRODUCE LARGE QUANTITIES.

Shantung produces about 2,125,325 piculs (of 140 lb. each) per annum from sea water. The Provinces of Chehkiang, Fuhkien, and Kwangtung all produce large quantities of sea salt.

Undoubtedly the Province of Szechuan, some 1,200 miles up the Yangtsze River from the sea, offers the greatest opportunities for the development of the sale of salt-manufacturing appliances. Salt in that province is the product exclusively of brine drawn from wells. The total quantity produced during one year is estimated at 5,500,000 piculs. In most parts the wells are few and far between; at Tzu Liu Ching a great number is found within a small area. Szechuan not only supplies its own millions of inhabitants with salt, but some 1,171,000 piculs to Hupeh Province annually; also to Yunnan and Kweichow, two neighbouring provinces. Many millions are invested in the industry.

The points at which rock salt and lake salt are produced are remote places, where it is doubtful if modern methods could be introduced at present.

OPPORTUNITIES FOR SALE OF PANS.

There is no question that the Szechuan district furnishes great opportunities for the sale of pans for salt manufacture, but freight rates through the gorges and rapids are so high that it would be difficult to deliver machinery into that district at a reasonable price. It is understood that a British company has maintained a special representative at Pekin, with a view to inducing the Government to instal modern salt-manufacturing appliances. It is not known how successful it was, but it is thought that certain improvements at the great Tientsin saltern are now under way, and probably some foreign machinery is being installed. Inasmuch as salt production is everywhere controlled by the Chinese Government, an attempt to introduce modern equipments should be made through the Government at Pekin, as it is not likely that private concerns, although they are the actual producers, would undertake any radical changes without the approval of the Government.

THE ARAROBA, OR GOA, POWDER OF BRAZIL.

The supply of araroba, or goa, powder is said to come entirely from the State of Bahia. It contains the substance known as chrysarobin, widely used in medicine in the treatment especially of parasitic skin diseases.

The product is found in the form of a pulp or small solid masses in crevices of the heart wood of the tree known locally as "amargoso do matto" (*Andira araroba*, of the natural order of the Leguminosæ), and is said to be a morbid growth. The trees are not cultivated, but are found in considerable abundance in the forests in various parts of the State of Bahia. They are of large size, from 80 ft. to 100 ft. high, and often attain a diameter of more than 3 ft. They have imparipinnate leaves, the leaflets of which are oblong, about 1½ in. long and ¾ in. broad, and somewhat truncate at the apex.

To extract the powder, the trees, which must have attained full growth and development, are felled and split open in order to reach the deposits of araroba at their centre. There is always present a very caustic liquid, of which no use is made and which is drained off. The damp pulp and lumps of araroba are then removed, dried, and finally powdered. The product is a bright yellow colour when extracted, but becomes a yellowish brown, varying considerably in tint when dried.

It yields about 50 per cent. of the substance known technically as chrysarobin, which is of therapeutic value. It occurs in a micro-crystalline, odourless, tasteless powder, very slightly soluble in either water or alcohol. Chrysarobin gradually oxidises to chrysophanic acid and glucose, and it is in the form of this acid that the drug is generally used. It is administered in the treatment of eczema, psoriasis, and in ringworm and other similar maladies.

The yield per tree may be as high as 60 lb. or 65 lb., although it occasionally happens that trees which are sufficiently large and old enough to give a good yield are found to contain no araroba whatever.

From a report by the United States Consul at Bahia, from which the above particulars are taken, it appears that the powder is an exceedingly dangerous article to handle, for if it enters the eyes it causes blindness, and burns from the caustic liquid referred to produce sores that may incapacitate the person afflicted for a long period. Those engaged in the work for any length of time, although protected by gloves and masks with glass eye-pieces, invariably lose their hair, eyebrows, and eyelashes, and sometimes even become blind. In a case known to the United States Consul a cat lost its fur after sleeping on a bag of the powder. It must be packed for shipment in hermetically sealed tins in wooden cases or it will not be accepted by shipping companies.

Immediately before the outbreak of the war some large shipments (amounting in all to 8,000 lb. or 10,000 lb.) were made to Europe and fully supplied the foreign demand for the time being, so that inquiries for it are only now beginning to be made again. It is said that abundant quantities are available, and that with sufficient inducement in the matter of price as much as five or six tons per month could readily be obtained throughout the year.

Unfortunately araroba lends itself to adulteration by the admixture of powdered wood from the tree with the pure powder, which is practically impossible to detect without analysis. The powder marketed is supposed to show a minimum of 50 per cent. of the pure drug upon analysis.

A NEW FIBRE PLANT IN CUBA.

Some further details are available regarding the "malva blanca" plant grown in Cuba, to which attention was drawn in the *Journal* of August 18th.

It appears that there are eleven known varieties of the so-called "malva" in Cuba, but that locally designated as "malva blanca" (*Urena lobata*) has been determined to be a very promising source of fibre, from which may eventually be woven the supply of sugar sacks for the Cuban market, while the finer varieties can undoubtedly be used in the manufacture of new fabrics for wearing apparel.

For several years experiments have been conducted in Cuba with the idea of utilising the malva fibres; but only in the last two years have the processes of extraction been elaborated on a basis that makes the extraction a commercial possibility. Malva fibre is now being manufactured and sold on the market at Habana, principally to the makers of alpargatas, or cloth shoes, worn by the labouring classes. The fibre is mixed with jute and used for soles. About 20 tons have been sold in the past year at 3*d*. per pound, and the supply is not nearly equal to the demand. The persons producing it claim that they can profitably produce and ship it for less than 1½*d*. a pound with the present crude methods, and that the cost would be considerably reduced with proper labour-saving machinery and equipment.

It is, however, as the fibre from which to make the 20,000,000 sugar sacks needed in Cuba annually that the owners of the process have the greatest hope for it. They assert that sacks of malva of 2½ lb. each can be placed on the market at 3½*d*. to 5*d*. each and still leave a profit. Normally, the Calcutta or Dundee sacks sell, delivered in Habana, at 8*d*. to 9*d*. each, and in war times have been selling at 1*s*. to 1*s*. 3*d*.

The malva fibre is claimed to have about the same textile strength as Dacca jute, and its fineness is between jute and flax. It is believed that by seed selection and cultivation the fibre can be improved in both strength and quality. According to a Report by the United States Special Agent in Cuba, sufficient results have already been achieved to demonstrate that the cultivated plant responds to good treatment, and comparisons with the wild plant show a better fibre from cultivated plants only one year removed from the wild seed. Seed is now being obtained from selected plants with a view to further tests.

"Malva blanca" is generally regarded as a troublesome weed by the tobacco planters of Pinar del Rio, where it grows best. In its wild state it attains a height of 20 ft. under favourable conditions, but usually averages between 6 ft. and 10 ft. on ordinary soil. During the growing season, it is claimed, it will make two crops of 6 ft. to 10 ft. where it is cultivated, and, according to the method of planting it, will produce a stalk ½ in. to 1½ in. in diameter. From the bark on this stalk the fibre is obtained. The plant requires a good soil. It grows wild under ordinary conditions, and the more rain and moisture it gets the better the growth. Windstorms do not injure it, and it is thoroughly hardy in the Cuban climate.

When the plants have reached a height of from 6 ft. to 8 ft. cutting is commenced, this being the best age at which to harvest. It is claimed that two cuttings may be made in a year without the necessity of replanting, new sprouts being thrown up from the stumps left in the ground. The present method of cutting is by hand, the men using machetes or cane knives, and striking a downward blow at the root. This frequently cuts below the buds and destroys the ability of the plant to throw out other stalks, thus curtailing the second crop.

Plants cut after a three or three and one-half months' growth show only one layer of fibre. Old plants that are allowed to go to seed without having been cut, it is claimed, show as many as eight layers of varying degrees of fineness, thickness, and strength; but it is difficult to extract them separately. For commercial purposes the three or three and one-half months' growth has been found best as a result of continued experiments.

At the experimental grounds several miles from the town of Vinalee, in the Province of Pinar del Rio, two methods of handling malva have been evolved. Both require the use of water. The cost of cutting under the present hand methods is about 12*s.* per 10,000 green stalks, or the labour of three men at 4*s.* each per day. They work with machetes or cane knives. The stalks are loaded upon waggons and taken to the retting tank or steeping pond. A waggon can carry only 100 arrobas (of 25 lb. each) at a load, and 4*s.* for each load is charged. It is purposed to use a movable bark-stripping machine, worked by gasoline power, which will handle the crop as it is cut and piled by the harvester. The 2,500 lb. of stalk would yield 20 arrobas (500 lb.) of bark; of this bark 5 arrobas (125 lb.) would be fibre. As much as 200 arrobas of bark could be piled on a waggon at one load, so that the initial cost of transportation from fields to processing vats could be reduced to about one-tenth of what it now is. Moreover, fewer men would be required than where the brush only is handled. The experimenters claim to have devised and patented an economical bark stripper.

The stalks or the bark are placed in the rectangular retting pond, which is about 25 ft. by 60 ft. and 4 ft. deep. The crude product is then weighted down in a solution of weak sulphur water, to which a small quantity of potash has been added. The potash hastens the elimination of mucilaginous matter in the stalks, adds whiteness to the fibre, and does not injure either strength or texture, so it is claimed. The bark or stalks remain in the solution from six to forty days, depending upon the temperature. The higher the temperature the more rapidly the process is completed. Steam pipes in the tank, it is asserted, would hasten the chemical action, make the results certain, and enable the workers to be independent of climatic conditions.

The other method is simply to place the stalks or bark in one of the running sulphur streams in the Vinales district. The fibre from the stream is much whiter than that from the pond or tank. Possibly the sulphur water has a bleaching effect; and, on the other hand, it is very likely the fact of being in clear running water, instead of the stagnant and none too clean water in the "retting pond," has something to do with this feature.

On taking the bark or stalks from the stream or retting pond, when examination has disclosed that it is ready to be worked, the process is slightly different for each method of treatment. The bark from the retting pond is then hung in the air and sun, and atmospheric action loosens the remaining particles of mucilage and bark, which are largely removed by vigorous shaking. On the other hand, the stalks removed from the sulphur streams have to be dried out. Women, who are paid 2*s.* a day, strip off the loosened fibre and tie it in "hands" or small bundles. This costs about £1 per 1,000 lb. The fibre, having been put into "hands," is ready for shipment, and is packed in open rope-bound bales of about 400 lb. each.

It is suggested by the experimenters that a dry kiln would hasten the process of drying materially, and if a carding machine and drawing frames were installed, these would produce a cleaner fibre, and moreover deliver it in "slivers," which could be done directly

into the press, and considerable economies in handling thus effected, besides giving a better quality of fibre. The combings from the cards could be worked over and sold for 1¼d. per lb., to be used for mattress filling, horse collars, upholstering material, and the like.

It is further suggested that in making the sugar bags machinery could be installed whereby the slivers from the carding machines would be carried on mechanically and worked into yarn to be used on the looms.

The present equipment at the experimental grounds referred to is crude, and is given as costing about £500. This includes the wooden "retting tank" alluded to, an 8 h.p. gasoline engine, a home-made "barking machine," which is patented and which is sometimes used for cleaning fibre badly dried as well as working the green stalks, a bale press, pump, and several hand machines for breaking up the stalks and taking the bark off.

POWER FROM TIDAL CURRENTS IN BAY OF FUNDY.

Efforts are now being made to utilise the swift tidal currents in the Bay of Fundy in the production of power. This bay extends from the Island of Grand Manan, off the mouth of the St. Croix River, in a north-easterly direction for about 150 miles. It separates the provinces of New Brunswick and Nova Scotia, and for two-thirds of its length from Grand Manan is a straight solid body of water some forty miles in width, then is split by a narrow neck of land into two almost equal legs, the left leg known as Chignecto Bay and the right leg as Minas Basin. In this great body of water the tides of the ocean rise to a greater height than anywhere else in the world.

At the head of the bay in the two legs mentioned the tides reach the height of 50 ft.; even at the city of St. John, on the main body of the bay, they rise 28 ft. to 30 ft. In some places there are very swift currents, exceeding, in fact, the flow of the swiftest rivers, and it is the utilisation of these currents for power that is now greatly interesting the maritime provinces of Canada.

The general flow in the middle of the bay is from one to two knots per hour, and the maximum rate at Digby Gut, on the Nova Scotia coast, is four knots, but in the right leg of the bay, known as Minas Channel, the rate is from eight to ten knots.

This rapid current, says the United States Consul at St. John, in an interesting report on the subject, is doubtless due to the peculiar shape and formation of a neck of land known as Cape Split, which extends up into Minas Basin in the shape of a hook narrowing the waters of Minas Basin at the extreme end of the cape to a very few miles. It is at this point that the waters of the bay offer the greatest advantages for water power, because, first, there will be no obstruction to navigation; second, it is an ideal situation for a power house; third, the swiftest current is here; fourth, here are the highest cliffs; and, fifth, it is the central position in relation to the needs of the provinces. Within a radius of 100 miles an urban population exceeding that of any city in Canada, except Montreal, can be reached.

Up to this time the use of tidal power has been almost entirely by means of large reservoirs, one of which is kept at high-tide level and empties through power gates to the other kept at low-tide level. Those who are promoting this power scheme at Cape Split because of the great current at this point expect to use just the tidal current rather than the head system. Storage will have to be provided for to meet the periods in every twenty-four hours when the tidal flow stops, and a specially designed motor will have to be made. These features are now taxing the skill of engineers and others who are endeavouring to harness the tides of the Bay of Fundy.

TESTING OF OIL-BEARING NUTS IN THE PHILIPPINES.

Investigations have been made by the Philippines Bureau of Science concerning the qualities of the calumpang nut, which has been found to be edible, though slightly purgative when eaten in quantities. The composition of the nuts, as analysed by the Bureau of Science, is: Fat (by extraction of dry seeds), 51·78 per cent.; protein, 21·61 per cent.; starch, 12·10 per cent.; sugars, 5 per cent.; cellulose, etc. (by difference), 5·51 per cent.; ash, 3·90 per cent.

The oil expressed from the calumpang is sweet, with a comparatively high melting-point. Its colour is a light yellow. One chemist reports that it appears to resemble olive oil very much in its physiological action. It is nontoxic, and has no irritating action. It can be used in the same manner as olive oil, and should be especially useful for culinary purposes.

Additional facts, writes the correspondent at Manila of the United States Department of Commerce, have also been ascertained concerning the oil-bearing nut, *Chisochiton cumingianus* (Harms), in recent investigations by local scientists. The plant belongs to the natural family in which the Philippine santol occurs. The nut is known in many parts of the islands from northern Luzon to southern Mindanao. The name applied to it in Camarines and Laguna, "balucanag," is taken to indicate that the natives recognise the nuts as oil-bearing, for the same name is applied to another and well-known

oil-bearing nut, although the two are not alike in any other particular.

The *Chisochiton cumingianus* (Harms) is described as half ellipsoidal in shape, when fresh, and as averaging 3 centimetres (1·18 in.) in length, and 2·5 centimetres in width at the widest portion. The shell is rather hard, constituting about 60 per cent. of the total weight, and it is difficult to separate it from the meat. In a quantity of shelled nuts tested by the Bureau of Science, which used petroleum ether for the purpose, about 31 per cent. of the whole nut was a reddish brown oil. The composition of the dry kernels was found to be as follows: Fat (by extraction), 44·12 per cent.; protein, 9 per cent.; ash, 3·19 per cent.

The dry kernel yielded 35·56 per cent. of oil on expression. The oil had a rancid odour, and was non-drying. On experiment it was found to have purgative properties. This oil, however, was found to have a weaker laxative effect than castor oil, five parts of it being approximately equivalent to one part of castor oil. This oil, more commonly called cato, was found by the Bureau of Science to be valuable for soap-making. One local firm now employs the oil in that industry.

OPENING OF THE FIRST RAILWAY IN PERSIA.

The following account of the opening of the first railway in Persia is from a report on the subject written by the United States Commercial Attaché at Petrograd (Mr. H. D. Baker), who had the opportunity of witnessing this extremely important event in the history of Persia. Mr. Baker reached Tabriz about the beginning of March last, travelling part of the way from the Russian frontier by the new railway, which was almost completed, and part of the way by carriage. Several days after, the railway was completed, and the first train arrived in Tabriz gaily decorated with the flags of Russia and of Persia. Thousands of people, including all the foreign Consuls and other officials in the city, came to witness the entrance of the first train, and there was immense excitement as the blowing of whistles announced its approach. In front of the locomotive was a huge emblem showing the Persian lion with the sword, with the sun in the background. The train consisted only of goods waggons, the railway being at present intended, not for carrying passengers, but for military purposes.

The great crowds waited to see the train start on its return journey. Through the courtesy of the Russian military authorities, the Commercial Attaché was permitted to be the first passenger on this first train on its return to the international boundary, one of the waggons being specially furnished for his accommodation. The train left Tabriz about 5 p.m., and the distance of ninety-three miles to Jhulfa, on the Aras River, separating Russian Transcaucasia from Persia, was covered by 5 a.m. the following morning. The journey would have taken three days travelling by carriage.

After the train left Tabriz it was interesting to watch the excitement occasioned among the rural population. In the different villages the people climbed up on the roofs of their mud houses to see this great spectacle; it was probaby the first time that most of them had ever seen a railway train. The sheep and cattle and teams of horses along the route were greatly terrified.

When the train crossed the bridge over the Aras River, its trip on the Persian side was ended. As there is railway connection here for Tiflis, and thence for all parts of Russia, there is no reason, says the Commercial Attaché, why it might not be possible for trains to run from any part of Russia to Tabriz, the chief commercial city of Persia. The gauge of the new line is the same as that of the Russian railway system, and the railway is under Russian control and management. Possibly the railway may be extended to Teheran, and thence south-east to Ispahan, in Central Persia, and into Baluchistan, where it could connect up at Nushki with the railway system of British India.

The railway now follows between Jhulfa and Tabriz the line of the Indo-European telegraph system of India. From the town of Sophian, about twenty-five miles from Tabriz, a branch of the railway has already been completed to Lake Urumiah, which is a great body of intensely salt water extending about 100 miles from north to south in north-western Persia. Around this lake is one of the richest districts of Persia, producing large quantities of raisins and other dried fruit, as well as considerable wine and wool. The completion of the railway to Lake Urumiah has made it possible to bring big motor-boats to take the place of the old primitive sailing-boats.

The railway to Tabriz, with its branch line from Sophian to Lake Urumiah, will doubtless cause an enormous development through all this part of Persia. Much new land will be opened up to agriculture, and various mines, chiefly copper and wolfram, will be worked, which have not been developed because of transportation difficulties. Although the railway is to be used at present only for military purposes, it is the intention later to devote it to the interests of trade between Russia and Persia. The railway will doubtless cause a diversion of traffic to a large extent from the caravan route from Trebizond in Turkey to the railway route *via* Tiflis and other cities of the Caucasus. Before the war the greater part of the trade of north-western Russia went through the port of Trebizond and through Persian and Russian ports on the Caspian Sea. The Caspian Sea

ports will still be used for business originating in and around Teheran, the capital of Persia, but it will be unnecessary hereafter for any of the business of Tabriz, the largest commercial city of Persia, to be conducted through Caspian Sea ports or through Trebizond on the Black Sea. The commercial importance of Tabriz, now the leading carpet market of the world, should be greatly increased. It is understood to have at present a population of about 200,000. Its bazaars cover many miles of arcaded streets, and its carpet bazaars are specially noted. Besides the enormous trade in carpets, there is an important trade in cotton, dried fruits, tragacanth, etc.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Mutual Accommodations.—The common problem is that of satisfying the demand for goods with a constantly dwindling number of men, and its solution is necessarily one of increasing difficulty. Hitherto the task has consistently turned out a little easier than could be expected. Circumstances adapt themselves in a mysterious way to the troubled manufacturer. Demand grows up for the sorts of goods which can be produced rather than for those which cannot, and by grace of small accommodations industry is enabled to proceed to good purpose. Cash turnovers receive the assistance of higher prices, and the amount of skilled work to be done in maintaining them is reduced by the avoidance of changes in the kind of work in hand. Carried beyond a certain point the reduction of man-power inevitably implies reduction of productive capacity, but it has been shown that upon an emergency unanticipated results are possible. There are mills and works producing goods of more total value than ever with the staff of skilled men cut down by one-half or two-thirds. As a fact of this kind is liable to misconstruction, it is necessary to emphasise the distinction between value and volume.

Restrictive Influences.—Manufacturers of goods indispensable for war occupy the privileges of their situation. They have first call upon the supplies of fuel, and are permitted to extend buildings while others are not; they have less difficulty in retaining the services of men of military years, and their applications for new machinery receive priority at the machine works. They alone are allowed to receive raw materials of particular sorts, but the privileges are bought at a certain price. Contracts are issued on terms which severely limit the charges which may be made, and convert the contractor virtually into an agent of the War Department. Increasingly the war becomes the first business of the industry, and the opportunities of attending to any other market diminish. Export cloths and home trade goods continue to be made upon one scale or another, but manufacturers have nothing like a free hand at present, and are perhaps destined to have less before regaining their liberty to go as they will. Doubtless it is widely recognised abroad that the situation of our textile manufacturers is singularly cramped, but without a strong effort of the imagination their exact position can scarcely be realised. The pre-occupation with war contracts removes the participants from their old trades, and precludes them from embarking upon the new ones that will have to be sought later.

Work after the War.—The resolute opposition to the proposal to apply the unemployment provisions of the National Insurance Act to workers in wool affords a test of opinion as to the effect of the ending of the war. Were it held seriously likely that large numbers of workers would be brought to destitution, a small weekly payment insuring a modest relief in case of need need hardly be grudged in present conditions. Virtually all the employers and all the employed concerned vigorously resisted the application of the Act, and were not dismayed to learn that no other financial assistance need be expected from the State. The industry accepted full responsibility for its own hardships gaily. The disbanding of the forces will bring the woollen industry contracts for the civilian suits, overcoats and cardigan jackets for which the King's Regulations provide, and were the war to end to-morrow it would catch the woollen warehousemen and clothiers almost without a piece in stock. While the war lasts the need for army clothing must be continuous and heavy, and when peace comes the call for goods will almost certainly be great.

Discarded Uniforms.—Arrangements have been made for firms of dry-cleaners in this country to receive soiled service uniforms, and to clean and repair them and send them out in a condition not very different from new. The bargain promises economies, and contracts have been made for the renovation of tens of thousands of uniforms weekly. Uniforms beyond repair are being collected for dispatch to the rag-wool district, where they are being bought at about £80 a ton for conversion into new cloth. Ordinary rag-picking is one of the industries that has been seriously disorganised by the war, and military rags, by virtue of the size and systematisation of the supply, are becoming the chief staple of the market. Except in a limited way, second-hand official khaki cannot be used to make standard khaki again. although it may serve for inferior qualities. Blended with rags of other colours, its fibres

may be looked for in fancy woollen cloths for the civil market. It is the exception to re-dye coloured rags even in times when dyestuffs are plentiful, and an observant eye will probably be able to trace some of these old uniforms to their new destinations.

Dyeware Syndicates.—The syndication of the French colour manufacturing firms following upon the amalgamation of the two great groups of dyeware companies in Germany, supplies an additional argument for combining together the principal British producers. Negotiations to that end have been in progress for some time, fostered by large consumers of dyes who have realised the dangers of isolation and of unco-ordinated effort. It is unmistakably true that dyers' colours can be more economically produced upon a large than a small scale, and a system allowing of the full specialisation of individual works is aimed at. So far as they are known, the schemes of the larger consumers provide for the amalgamation of the four principal colour manufacturing concerns in this country, with opportunities of including other factories later. The combined works would receive Government support in return for a participation by the State in the profits. For the encouragement of colour producers at large, a substantial duty would be placed upon imported coal-tar colours. The conditions cannot be said to have been fully agreed upon by the authorities whose assent is indispensable, but a strengthening of the British position more or less upon these lines may be expected. It is certain, in any event, that the arrangements made last year for the promotion of colour manufacture in this country are to be revised. In putting the eggs all into one basket great responsibility is thrust upon the central control, and it may be said that great importance is attached to the selection of some one business man with the gift for eliciting the best from chemists, engineers, managers and subordinates, and with power to put each in his proper place.

Puttees.—The prototype of the modern puttee is possibly the hay-band, as worn by the rustic who has to cross snow-filled fields. It may be observed that as far back as Anglo-Saxon times, bands known as *scanc-beorg* were worn around the leg. Puttees can be said to have been worn before stockings, and to have been wound round the leg both in the simple spirals and in the cross-gartered fashions that are affected to-day. To trust illuminated records, kings wore puttees of gold, and as the laity in France wore them of woollen, the monks of St. Gall were commanded to bind their legs with fillets of linen; for distinction. Leg bandages as military costume seem to have passed out of date in the fourteenth century; but puttees, or *lingettes*, were part of a French butcher's dress up to the sixteenth century. Puttees came into modern English prominence with the Boer War, recommended by a character obtained in the East. Horsemen wearing cotton or linen bands round the leg had certainly made public appearances in this country earlier than the South African War, but the wider recognition of the article came at that period, since when acquaintance with it has improved. A distinction may be drawn between the puttee, which is a simple strip of cloth with no natural disposition to follow the curve of the calves in the beginning, and the spiral stockinette puttee curved in its manufacture and winding smoothly around the leg without folding. There is again the elastic puttee, made upon the same principle as some surgical bandages from yarns twisted so hard in course of spinning that their constant endeavour is to contract. Except in neatness of appearance, and in the detail of structure, one is much the same as the other, and all of them convey a reminder of the wrappings affected by the Saxons and Danes.

Peruvian Textiles.—Mr. M. D. C. Crawford describes his "Peruvian Textiles" (Anthropological Papers, American Museum of Natural History, 1915) as but an introduction to more exhaustive research, and with this description there is no need to quarrel. The paper relates to the features of fabrics found in the graves of coastal Peru, and gives details pointing to a high degree of manual skill on the part of these primitive spinners and weavers. It is perhaps inevitable that ethnologists, in their examination of ancient processes, should spend a large part of their space upon the rudiments of manufacture and betray some unfamiliarity with technical terms. Mr. Crawford, for example, would have contributed to ease of understanding by calling the weft-carrier a shuttle instead of a spindle. The stick used to carry weft in weaving may be very like the piece of stick used in spinning, but nothing is gained by ignoring the difference of office. Mr. Crawford succeeds in calling attention to the wide range of fabrics made in ancient Peru, and he takes it as certain that these productions owed nothing to outside influences or instruction. "Those great textile masters of antiquity" are lauded for fabrics which "have never been equalled from a technical point of view," and for dyeing work than which "no better has been ever done." These encomiums are perhaps too facile, and a more critical attitude towards the specimens of which the museum is justly proud, and towards some authorities upon whom the author is content to rely, would carry more conviction than Mr. Crawford's fluent enthusiasm. A second paper, in which analyses and diagrams are promised, should give a fuller idea of the excellence of Peruvian workmanship. Manufacturers are, of course, better able to appraise

technical excellence than are ethnologists who may be warned against the pursuit of technical matters to the neglect of their historical duties. It is not so necessary to vindicate the Peruvians, the Egyptians, Persians or Africans, as to present their achievements in their historical sequence as carefully as chance allows.

GENERAL NOTES.

Potash from Kelp in California.—Attention is drawn in *Nature* to experiments conducted by the United States Department of Agriculture of extracting potash from kelp. Before the war the United States imported annually from Germany some 300,000 tons of potash. It is believed that the vast beds of this weed growing along the Californian coast will suffice to furnish all the needs of the country, and large quantities are already being placed on the market from this source. But, according to *California Fish and Game* for July, fears have been expressed that the cutting of the kelp will have an injurious effect upon the fisheries of the State, and this because of the protection afforded by the weed to the braches, and the danger of exterminating the clams and spiny lobsters which live more or less within the protection of the kelp. They also fear that the young fish which are in the habit of seeking refuge here will be driven away, and further that such fish as spawn here will similarly be destroyed. These several objections have now, however, been carefully examined, and it is pointed out that the kelp-cutters do not cut below 6 ft., thus leaving ample shelter. It may be, indeed, that the cutting will prove beneficial, since the weed will be less easily torn up by storms. The species of kelp which is thus being harvested is *Macrocystis pyrifera*, a plant which ranges in length from 100 to 300 ft.

Professional Classes War Relief Council Maternity Home.—In order to assist the wives of professional men hard hit by the war, the Professional Classes War Relief Council maintains, at 13 and 14, Prince's Gate, S.W., a maternity home where expert care and nursing is offered for a nominal fee. This has been made possible by the generosity of the medical and nursing staff, who give their services voluntarily. Since the home was opened in 1915 one hundred and eighty births have taken place there, and the Council has also given considerable outside assistance to a large number of applicants whose family ties have prevented them from leaving their own homes. Applications should be made to the Secretary at the above address.

Cattle for Alaska.—Owing to the extreme rigour of the winters in the interior of Alaska no breed of dairy or beef cattle has as yet been found which can exist there without excessive expense for food and protection against cold. As a result the price of milk is about fifty cents a quart, and the beef consumed in the country consists almost entirely of cold-storage meat imported from elsewhere. In the hope of remedying this situation the Alaska experiment station, according to the *Journal of Heredity* (Washington), has undertaken to cross Galloway cattle with the Yak, an Asiatic ox much used by Mongolians and Tibetans for milk and meat as well as work. It is employed as a beast of burden at altitudes of 12,000 feet or more; it is extremely hardy, pastures through the winter under the open sky in Siberia, and obtains feed from last year's dead grass dug from under the snow. Crosses of the Yak and various breeds of domestic cattle are common in parts of Asia and have been found of much value.

Launch of the largest French Liner.—A new transatlantic liner named the "Paris" was successfully launched at Saint Nazaire on September 12th last. This vessel, which belongs to the Compagnie Générale Transatlantique, is intended for the service between French ports and New York, will, when completed, be the largest vessel in the French mercantile marine. Her length is 233 metres (764 ft. 3 in.), beam 29·60 metres (96 ft.), depth of hold 18 metres (69 ft.), gross tonnage 37,000 tons, and draught 9½ metres (31 ft.). The engines will have 45,000 nominal horse-power. There will be accommodation for 3,000 passengers.

Italian Irrigation.—The construction of two new channels for the irrigation of a large tract of country in the province of Novara is contemplated by the Italian Government. These canals, which will be called the "Elena" and the "Yolanda" canals respectively, would be derived from the River Ticino, and would serve to irrigate the district known as the "Alta Novarese," or country lying too high to be watered by the Canal Cavera.

Cinema Industry in the United States.—An Hispano-American journal, *Las Novidades*, of New York, gives the following statistics respecting the cinema industry in the United States. At the Sixth Congress of Exhibitors of Cinema Films, recently held at Chicago, it was stated that at the present time there are no fewer than 21,000 halls and theatres at which this class of entertainment is given in the United States. These entertainments are attended by no fewer than 25 million persons daily, or say more than one quarter of the entire population of the States. They employ upwards of one quarter of a million operators, whose weekly wages amount to 2,300,000 dollars. The total amount in these undertakings was stated to exceed 2,000 million dollars (£400 million sterling).

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

VIBRATIONS, WAVES AND RESONANCE.

By J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E.

Lecture II.—Delivered May 8th, 1916.

WAVES IN PONDERABLE MATTER.

When we met last week I pointed out to you that if I could make a vortex ring vibrate sufficiently rapidly you would hear a musical sound. Now it is possible that this is actually realised in the flight of a bullet or shell. You have no doubt seen Mr. Boys's beautiful photographs of a flying bullet, and have noticed that, in addition to the compression waves which slope out from it like the bow waves of a ship, there are many small vortices in its wake. It is quite likely that these may be in sufficiently rapid vibration to act as sources of sound waves, and thus to add to the sound produced by the compression waves.

To-day we tackle the subject of waves in ordinary matter—such waves, for instance, as those of the sea, of clouds in the sky, and of sound. I shall not attempt to deal with breakers, in which the water at the top of the wave actually runs continuously forward in the direction of the wave motion, but shall stick to periodic motions such as those of waves in deeper water or of sound in air or other materials.

The first great thing to notice about a wave is that, although the wave travels steadily forward, any given particle of the material in which it is travelling merely executes a to-and-fro motion. A wave is, therefore, the forward motion of a vibration, but not the forward motion of matter. It is in fact the motion of a motion. There are two principal kinds of waves, the transverse and the longitudinal, these names being given from the direction of the vibration of the medium. In the transverse wave the motion of the material is to and fro at right angles to the direction of motion of the wave. Here, for instance, I have a long strip of corrugated paper lying on the table. I lift one end quickly and bring it down again: a wave runs right along to the far end. Quite obviously the paper does not travel with the wave; it merely rises and falls again at points successively farther and farther from my hand. The wave travels on, however, and is quite as clearly a wave as any other you like to name. Here, again, is a rope stretching from one end of the hall to the other. I give it a transverse impulse by striking it sideways near one end, and you see the wave running along it to the opposite wall, where it is reflected and comes back to me.

In a wave of the sea, *i.e.* a surface wave in a liquid, the vibration is also transverse—that is to say, any particular particle of water moves up and down as the wave passes along. You all know from experience that a cork on water merely bobs up and down and does not travel forward with the wave. If the water went forward, of course, the cork would go too.

Perhaps the simplest way to understand the motion of a water wave is to study the comparatively simple type produced by dropping a stone into a calm pond. In these diagrams, lent me by Professor Silvanus Thompson, we see the progress of the motion. Firstly, the stone strikes the water, pushing it out all round, and, as water is nearly incompressible, the water near the stone has to *rise* to make room for the stone. It cannot go down—there is water there already; it cannot go far sideways because of the inertia of all the water in front of it; so on the whole it must go up. Having risen in a ring all round the stone it is now in an unstable position; there is no permanent force to hold it up, so it falls. In so doing it pushes up the water just outside it, and this in turn falls and pushes up the water farther out. There is thus produced a ring of

raised water of constantly increasing diameter, and this is the circular wave which you see travelling outward in all directions from the point at which the stone fell into the pond. With the exception of a small outward movement in the water close to the stone, the motion of each particle of water as the wave passes is up and down in a narrow ellipse which nearly approximates to a vertical line. The smaller waves which follow the first as a series of concentric rings are due to the inertia of water. Just as in the other vibrations which you have seen, the water raised by the stone does not come to rest when it first reaches the general level of the surface, but goes on in a downward direction, thus making a circular wave of depression which follows the raised ring, and at the same time raises a central peak in the water behind it where the stone fell through the surface. This peak in turn falls down and starts a second raised ring, and the action goes on repeating itself until the energy of the stone's impact on the water has been all used up in producing the waves, and till finally these die out through molecular friction and this energy is turned into heat.

The production of waves by a ship as it is driven through the water is a similar phenomenon. As the wedge-shaped bows of the ship press the water outwards it rises, and in falling propagates a wave which travels outward, just as in the case of the stone dropped into water, but with the difference that the source from which the waves start is moving rapidly—indeed, more rapidly than the waves themselves. Hence the exquisite retreating curves in which the waves spread out on either side of the ship. You can see something of them in the photograph, taken by Mr. Vaughan Cornish, which is thrown on the screen; but it is far better to watch them for yourselves from a height overlooking some calm waterway where ships go to and fro. Why, even London Bridge will do!

There is an interesting case of ship waves which you may have noticed, that of the tramp steamer ploughing her way down Channel with a great foaming wave right across her bluff bows—a "bone in her mouth," as seamen call it. Here the speed of the ship is no greater than that of the wave produced, and instead of curving away like an arrowhead the wave stretches out on both sides, nearly at right angles to her course. In this it is like the stern wave of all vessels, which, rising under the stern, spreads out and settles down after the ship has passed into nearly a straight line.

In this other picture you see a similar type of wave, produced this time by the flow of water over a ridge of shingle. It is the lower end of Loch Lubnaig, in Perthshire, where the stream runs out. The quiet water of the loch flows towards the gravel beaches as they converge to form the banks of the stream, and underneath the surface the spits of shingle are like two ploughs with water flowing past them. You see the waves produced by each are just like those of a steamer, though in this case it is the water that moves and the vessel that is at rest. Such waves as these are seen above a moving submarine, even when it is travelling far below the surface.

The generation of waves by wind is not so simple, though what is produced is, as before, merely an up-and-down motion of every drop of the ocean. But there is this difference—that the longer and harder the wind blows and the further the wave goes, the more the motion grows. Let us see how it starts. In the first place, when one fluid—air—is moving over the smooth surface of another fluid—water—the motion is unstable, and for the following reason. The smallest extra downward pressure of air on a patch of water will cause a slight hollow and, of course, a little rise in front. As the air travels up the rise it will shoot over the top, and just behind the crest there will be a partial vacuum, very slight, but sufficient to encourage the crest to rise a little higher. Thus every time the water rises in its place it will be to a little greater height, and everywhere the up-and-down motion will increase. The result of this will be that each wave which travels off down wind from the initial place of vibration will be larger than the one before, and that the farther the wave goes the larger will it become, for at any position its energy is that of a vibration which has grown in amplitude from two causes: firstly, by superposition of the waves coming down wind to its position; and, secondly, by the action of the wind in its own locality. In the photograph of the Luss Straits on Loch Lomond, which you see on the screen, this growth of the waves under the action of the wind is very obvious. On the left the waves are small, but down wind towards the right they grow both higher and longer from crest to crest as they go.

The explanation I have given you of the growth of waves at sea has not, as far as I am aware, been put so fully in words before, although there is a suggestion of it in a paper of Lord Kelvin's. It accounts for the more obvious phenomena of sea waves and also

throws light on some of those less commonly noticed. I have, for instance, observed the following in watching a rough sea. All the large waves come towards one in a comparatively regular succession and with practically the same speed. If, however, one notes that a certain wave is larger than the others and watches it, one finds that, although it travels in the procession as a wave, it only continues to be unusually large for a very short time—in fact, it loses its characteristic size as it travels, and the wave behind it in turn becomes a large one. The maximum vibration thus travels forward much more slowly than the individual waves. This is a curious observation. It does not mean that a long wave, *i.e.* one which is long from crest to crest, travels more slowly than a short one, for the reverse is true except for small ripples, but that in a series of waves, all of nearly the same length, a wave which is particularly high at one place does not continue to be a high one throughout the whole of its course, but leaves its height behind it as it progresses. That is to say, the place of maximum vibration lags behind the actual wave motion. Since the velocity of a wave increases as the latter becomes longer in travelling down wind, the probable explanation of this phenomenon is that the extra height is due to the superposition of the two wave trains of slightly different wave length, and therefore travelling with different velocities. Their crests will thus coincide and give maximum waves at certain points which travel forward with a velocity less than that of even the smaller waves. This type of phenomenon, due to the difference in the velocities of waves of different length, does not appear to have attracted the attention it deserves, perhaps on account of the fact that in certain media all waves appear to travel with the same velocity.

When the difference in wave length is great, as, for instance, in ordinary sea waves with a ground swell coming in, where each of the longer waves is many times the length of the others, there is a somewhat different effect. Atlantic waves are sometimes considerably over a thousand yards between one crest and the next, and as these come in at about one per half minute, the result is more like a tide than a wave. Apparently the whole sea rises with all the smaller waves on its surface and sinks again. Sitting on the rocks at the mouth of Pornic Cove, in Brittany, I have watched a tide which ebbed and flowed once in every five minutes. The rise and fall totalled about a couple of feet and was quite regular and definite. Two explanations are possible. Either it was an immensely long Atlantic swell coming in, or, what was perhaps more likely, it was the natural vibration of the water in the cove—a deep and narrow harbour running about a mile into the land. Many cases are known of such vibrations of large masses of water: in the Scottish lochs, for instance, they are continually occurring, being started by differences of wind pressure on opposite ends or sides of the lake. A very careful survey of these motions, and of their relations to the depths and forms of the lochs in which they happen, has been made, the results being published in the Proceedings of the Royal Society of Edinburgh. The technical name for such a little tide is the French word "seiche," they having been first observed in the lake of Geneva. The common saying that the seventh wave is always the greatest is probably a recognition of the fact that there is usually on all sea coasts a swell of great wave length in addition to the smaller waves of more local growth.

I shall now show you a simple experiment which illustrates very clearly some of the more important laws of wave motion. Here is a large photographic tray in which there is some water mixed with a considerable proportion of syrup to make its movements slower, so that they may be more easily followed by the eye. I place an arc lamp near it, the light of which is reflected from the water surface and thrown upwards on the screen as an oblong patch. You see that the slightest disturbance causes a ripple in the water, which travels across the tray and is reflected from the other side. If I touch the surface with a small stick, or let a drop of water fall on it, a rapidly growing ring of concentric ripples travels outwards till it touches the side and then is reflected back. Notice that the reflected ripples cross the band of incoming ones without stopping their motion or being in the least distorted themselves, and in fact that each wave travels onwards just as clearly and independently across the others as it would do on a calm surface. You can see clearly that when a band of ripples crosses another band and arrives again in a calm surface, it is quite evident that it has suffered no distortion in the process. The essence of this observation is that waves do not destroy or even confuse one another, but that each goes on its own appointed course as if none other existed. Thus it is that we can hear sounds from many sources at once and distinguish them, and that the ground

swell does not obliterate the cross sea on its surface.

I may now state this as a law of wave motion: Any number of wave motions may co-exist independently in any medium without mutual distortion, and the motion of any portion of the medium is simply the result of the superposition of the waves passing through it.

If I strike the table with my hand you see straight bands of waves starting simultaneously from all sides of the tray. They travel forwards, making a tartan pattern, and, crossing one another at the centre of the dish, arrive at the sides opposite those from which they started quite unchanged. If, instead of giving a single stroke, I continue to beat the table at short intervals, the tray becomes full of these waves, and the result is a fine chequered pattern of bright points and dark lines covering its whole surface. These appear to be merely rising and falling at fixed points, and for this reason are sometimes called stationary waves; but the moment I stop beating the table, you see that they are really just the points where several sets of travelling waves cross one another. One can see an effect like this wherever waves cross one another, and very clearly near a sea wall or stone pier. The reflected waves travel back through the incoming ones, and where two crests meet the compound wave rises to a great height, often breaking into spray. A "jabble" is the technical name, and well describes the apparent wildness and irregularity.

The same effect can be seen in the long stretched rope if I give it a second impulse just as the first has reached the far end. The two then meet in the middle, and, as the reflected one is returning on the other side from which it went out, apparently cancel one another at this point, but pass on nevertheless. By repeatedly striking the rope at intervals, each equal to the time taken by a wave to travel from one end to the other, I can keep this motion going, and the string continues to vibrate in two sections with a quiet spot at its centre.

The speed of a deep-sea wave is proportional to the square root of its length from crest to crest; but in shallow water another rule holds good. If you watch a long swell coming in from deep water over a slowly shelving bottom you will see that the distance between crests is gradually reduced, showing that the speed of a wave in shallow water is less than in deep. The case of waves in a canal is an especially interesting one, and has been calculated by Lord Kelvin. He found that there is a limiting velocity faster than which a wave will not go. This is illustrated very neatly by the way in which the passenger boats used to be run on the canals in Scotland. These were light and shallow vessels, not like the great barges now used for freight-carrying, and were drawn by a pair of horses. At first their speed was that of a walking horse, say four miles an hour, and at this rate they travelled with a large wave always just in front, and it was hard work for the horses. One day the horses bolted, the barge was jerked forward over the top of the wave, and, to the surprise of the driver, continued to move forward quite easily at about ten miles an hour without creating any wave. After this the obvious method of whipping up the team at the start and then keeping them at a steady trot was always adopted. The fact was that they were now going as fast or faster than the most rapid wave possible on the canal. Thus no wave was produced, and no energy to speak of was wasted in churning up the water.

A type of wave which I have not hitherto mentioned is the ripple, by which I mean the little waves less than an inch from crest to crest, which do not mainly depend on gravitational force, but are controlled chiefly by the molecular attractions between adjacent molecules of the liquid. The effect called surface tension is produced by these forces, and its result is as if the surface were a solid elastic sheet. The speed of a ripple, unlike that of a larger wave, is greater as the length is less—a fact very easily observed in water. Here I must remind you that all the water waves with which we have dealt are surface waves in fact, and for this reason are more complicated than internal waves, such as sound waves in air, or electric waves in a large mass of dielectric. There are, of course, surface phenomena in all wave motions at the interface between two media, but in sound and electricity the internal waves exist and are important, while the only truly internal waves in water are either sound or electric, for the ordinary waves are solely due to the fact that above the water there is the air—a fluid of much less density.

Even in the atmosphere itself surface waves are possible, for there are sometimes sharply marked layers of different density. Here is a photograph which shows you a series of long straight clouds lying in parallel lines, just like the crests of a swell. Such, indeed, they are, being the tops of great air waves in which the moisture has become condensed as they rise, thus rendering them visible: they indicate that

in the upper layer the air is blowing across the air beneath it, just as the lower air blows across the sea; but they travel slowly, for the difference of density of the two layers is small, and on this depends their speed. In another of these pictures we see, from above, a wonderful sea of clouds, which at first sight appear to be piled at random away to the farthest horizon; but on closer examination an order is evident, and many parallel ridges are clearly discernible. Now when a fluid surface shows such a definite formation one seeks an explanation, and in this case that of wave motion is the only one which fits. Indeed, whenever a fluid shows a structure in parallel lines the presumption is in favour of a wave motion being the cause.

There is one great set of waves, so large that we do not recognise them as such, which is of the utmost importance to us as an insular people—I mean the tides. If the globe were covered to a uniform depth with an endless sea the tide would be quite a simple motion; but as it is, with the ocean broken up by continents and its depth varying from several miles to a few score feet, it becomes a most complex procession of waves whose periods can only be determined by prolonged observation. But once determined and analysed into their simple harmonic components they can be predicted for years ahead. This sounds remarkable, but really the process is quite simple. First one determines the component simple vibrations by graphical or mechanical analysis of the record of past tides at the station. Then one adjusts each of the vibrators of the tide-predicting machine to represent by its motion one of these component vibrations, and thus the end of the cord, which passes over all the vibrators, performs a complex vibration, and records the form, height and period of the tide required on a moving strip of paper. The tide predictor is a frame in which are set two horizontal rows of pulleys. A cord, fixed at one end and free at the other, passes over an upper pulley, then under a lower one, and so on up and down across the board. At its farther end is a weight with a pen attached. Each pulley can move up and down in a vertical guide, and is made to do so at a properly chosen rate by gearing behind the frame. Hence, as each pulley moves it lengthens or shortens the bight of cord which is round it, and alternately raises or lowers the weighted pen at the free end of the cord. As all of the pulleys are working on the cord at once, the movement of the pen is simply the sum of their separate motions.

I have constructed a simple machine which will show you this composition of harmonic motions, though in this case the vibrations are damped and not uniform, like those of the tide predictor. It consists of two weights hung on helical springs, which are attached by their upper ends to the top bar of a trestle. A horizontal rod is connected by flexible couplings to both the weights; it runs in fact through the rings on them, and is held in position by fine cords. One end of the rod projects beyond the weights, and has a small paint-brush fixed across it horizontally. If I now set the weights in vertical vibration the paint-brush performs a complex up-and-down motion which is compounded of the separate vibrations of the weights, and by drawing a sheet of thick paper steadily past the brush I obtain on it a wavy line giving the form of the compound vibration. Also, by keeping either weight still and letting the other vibrate alone, I get its wave form: so here you have the records, not only of the compound vibration, but also of each of its simple harmonic components. By hanging additional weights on one of the vibrators you see that I obtain another form of record, and that if the frequencies of the vibrations are not greatly different the motion is a curiously complex one. To find how long it will be until the record begins to repeat itself is really a problem in our old school friend the L.C.M., so that hackneyed rule is of use after all; I say to repeat itself, though with this machine this is hardly exact, since as the vibrations are continually dying away they never are repeated in size, although they are in form.

The model, lent me by Professor Thompson, which I now show you demonstrates a very curious type of vibration. As I move it you see that each of the knobs at the top of the rods describes a nearly circular curve in a plane perpendicular to the wave, and that the wave travels forward with a cork-screw motion. In this other model, which consists of a ladder of tape with knitting-needles as rungs, we get what at first sight appears to be a similar wave form; but it is not so, for in this case the ends of the needles reverse their motion and rotate to and fro, whereas the knobs in the first model moved continuously round in circles. The second model shows torsional waves such as are easily produced in rods or masses of elastic material, and are in fact of very great importance in propeller shafts and other structures. I have seen them, for instance, in a long corridor carriage travelling at high speed on one of our

main lines when looking along the corridor from one end to the other.

From the experiments which you have now seen you will realise that the vibrations which generate a transverse wave may be either in straight lines at right angles to the direction of the wave motion, or in curves of any form in planes at right angles to the same. When we have stated the character of the vibration we have defined the property of the wave which is termed its polarisation.

All the waves which we have considered thus far are transverse in nature, and amongst those of this class are also included the waves which we know as electric and as light and heat. There is a smaller but still very important class, in which the motion of the material through which the wave passes is to and fro in the direction of the wave itself. These are called longitudinal waves, and are only found where the medium is compressible either on account of its nature or because the wave is merely carried along a rod which is free to expand or contract in lateral directions, since it is surrounded either by a compressible or by a fluid material. I shall show you examples of both types of longitudinal wave, and, as it is perhaps the simplest to demonstrate, I shall commence with a longitudinal wave on a long rod or cord of elastic material surrounded by air, which, by the way, is both fluid and compressible.

Here I have a long thread of indiarubber, on which I have strung at equal intervals a number of small leaden weights in order that the wave may be slowed down so as to be visible by you. To keep the indiarubber in a straight line, it is supported from a horizontal bar above it by a number of cotton threads; these do not appreciably interfere with or alter the wave motion which I am going to show you. At one end of the rubber a small lever and flag are attached so that those of you who are not close at hand may see the arrival of a wave more easily. I now pull and suddenly release the near end of the rubber cord. You see the impulse running along it made visible by the crowding of the little leaden weights. This crowding, which is in fact a compression wave, runs along to the far end and wags the flag. Keeping your eye on any one of the leaden beads, you see that it merely moves to and fro lengthwise as the wave passes. The wave is thus truly longitudinal, the vibration of any particle being forwards and backwards in the direction of the propagation of the wave. If you watch closely, you will see that the wave is reflected from the far end and returns to my hand just as in the case of the transverse wave on the long rope, and if I give the cord a succession of little tugs at proper intervals I can produce stationary waves with a quiet spot half-way along the indiarubber in the same way as with the rope.

I have said that I loaded the rubber thread with leaden weights in order that the wave might travel more slowly. It is quite easy to show you that adding inertia does retard a wave. This piece of cord, about 30 ft. long, is loaded for 10 ft. of its length at the end farthest from me. If now I start a series of waves so that the cord gets into stationary vibration, you see that, while there are two vibrating segments in the loaded portion of 10 ft., the whole 20 ft. of unloaded cord vibrates as one. Now the length of a segment, *i.e.* the distance between one node and the next, is inversely proportional to the velocity of the wave running along it, for the times in every case are the same, as is also the number of impulses per second. Hence, since the unloaded segment is four times as long as one of the loaded ones, the velocity of the wave in the unloaded part is four times that in the loaded portion. To make this more evident, suppose we cut 5 ft. off the loaded section of our cord. The cord would then be 25 ft. long and there would only be one node, *i.e.* at the commencement of the loaded section, in addition to the fixed points at the ends. Now imagine two impulses starting simultaneously in opposite directions from this node, and travelling to the ends of the cord and back again. Clearly, if the node is to remain a node, *i.e.* a quiet point, the two impulses must again pass simultaneously through the point from which they started. Hence the time taken by an impulse to travel over each segment of the cord must be the same, and, as the unloaded segment is four times as long as the loaded one, the velocity in it must be four times as great. Loading the medium along which a wave passes, therefore, slows its progress. We understand why this is so when we reflect that the rapidity of a wave's motion depends on the rate of the local vibrations which constitute it, and that these are slower the greater the inertia of the vibrating body. The same is, of course, true whether the vibrations be transverse or longitudinal.

I shall now show you by a simple method which I discovered some years ago, the movement of a sound wave in air. On the table a yard or more away from me I place a lighted candle. Standing facing the candle, I hold a

piece of stiff cardboard about 1 ft. square in both hands in front of me. If now I suddenly pull the cardboard towards me, you see that the flame is momentarily drawn over towards the retreating card. I place a second candle a foot or two beyond the first and repeat the experiment. Now both flames move with the motion of the card and, as nearly as can be judged, at the same moment. Clearly, therefore, the rate at which the disturbance travels through the air is high, certainly more than 100 ft. per second, for if it were slower the eye could notice that the near candle flame flickered before the farther one. The disturbance cannot, therefore, be a draught of air in the ordinary sense—that is to say, it is not caused by air actually flowing across the room. What happens is this. Jerking the card towards me leaves a partial vacuum behind it, since the neighbouring air cannot instantly flow in because of its inertia. The air against the card is, therefore, momentarily rarefied. Into this partial vacuum the air immediately beyond it commences to fall, becoming itself rarefied in the process. Then the air immediately beyond this falls in, and so the rarefication travels on until, on reaching the candle flame, this falls in also and shows you the presence of the wave. A very similar action is visible in a large heap of sand or fine gravel when a spadeful is taken out of one side of it. The sand commences at once to fall into the vacancy, and the falling-in process keeps on spreading farther and farther until an equilibrium is reached.

I have called this a sound wave, as in fact it is, although your ears are not sensitive enough to hear it. If I could move the card more rapidly, and thus produce a better vacuum, you would hear a single thud owing to the outward motion of the drums of your ears as the rarefaction came along to them.

If instead of pulling the card towards me I push it suddenly away, I produce a compression wave which travels exactly as does the rarefaction. It is not so easy to show you, however, as one's muscles are not so well suited for a sudden push as for a pull. Probably the greatest wave of this kind on record was that given out by the volcano of Krakatoa. I have already mentioned how it was heard as a loud sound after travelling fifteen hundred miles, and was detected by sensitive barometers after it had gone one hundred and forty-four thousand miles —*i.e.* six times round the globe.

Another interesting case of sound transmission is the submarine bell. In water, on account of its very small compressibility, a sound wave travels about four times as fast as it does in air, and, when once started, it has considerable energy owing to the density of the water. The result is that under water it is no uncommon thing to hear a submarine bell at a distance of sixteen miles, and the more powerful sound of the Fessenden hooter has been heard at fifty-five miles off. The latter is something like an electric motor-car hooter on a very large scale. A steel disc is caused to vibrate rapidly by an electro-magnet carrying an alternating current; it produces a succession of waves of compression and rarefaction in the water, and these are appreciated as a tone in a telephone connected to a microphone which is immersed in the sea. Submarine bells are now very largely used in navigation in all parts of the world, but especially on the eastern coasts of America, where scores of them are located on sunken shoals and as guiding points near the entrances to harbours. Most transatlantic liners are fitted with the receiving apparatus, which consists of a pair of microphones, each enclosed in a box full of water fixed against the plating of the vessel *inside*, on either bow. If the ship is heading straight for the bell the sounds picked up by the microphones are equal in strength: thus the bearing of the bell can be determined and the proper course set. In thick and foggy weather the bells have proved to be of the greatest use.

In my last lecture I showed you that musical tones and articulate sounds are merely certain types of continued vibrations, and since the waves given out by them are really the same vibrations in motion from place to place these waves have the same characteristics. The strange thing is that, although each set of waves is independent of the others in the sense that it travels on its course undiminished and undistorted by the others it may meet, the actual vibration at any particular point, at the drum of your ear, for instance, being the sum of all the pressures and rarefactions arriving at each moment, is in itself merely an alternation of pressure and rarefaction—not a simple harmonic vibration, of course, but a harmonic variation composed of many simple components. It can therefore be represented by one wavy line, apparently irregular, but in reality composed of many simple harmonic motions. This one line represents a motion which is very simple as regards space; it is in fact merely backwards and forwards in one short straight line, but may be infinitely complex in time. Thus it is that the little wavy

scratch on a gramophone disc or the tiny pitted groove of a phonograph may be the completed record of the sound waves of a band of many instruments, of a single human voice, or of the confused babel of a market-place. There is no further mystery in either of these instruments. Inside the box there is only ordinary clockwork, and the reproducer is merely a fine needle attached to a little glass or mica disc. The mystery of the music is wholly in the wavy line. Once you have got some way of making a piece of material large enough to cause audible compression and rarefactions in the air, to move according to the wave forms frozen on the record, you can obtain again the sounds they represent. Here is an ordinary gramophone record rotating at its proper speed. I hold a thin calling card with one corner in the groove. As the record turns the card is forced to vibrate with the wave forms which have been impressed on the groove, and so gives out the sounds—faint, no doubt, for the card does not take so firm a hold as does the needle of the reproducer, but quite clear and distinguishable.

Do not forget that in the air and even at the drum of your ear a sound is nothing but alternate compression and rarefaction, or a mere to-and-fro motion—the music is in your mind alone; it is a picture painted, not in space and colour, but in time and motion, and, like other pictures, pleases or displeases by the conception of harmony which it gives. It was something of this sort that Fourier meant when he said that if one could comprehend at once the laws of the diffusion of heat it would give one the sensation of music, so beautifully do they harmonise.

It might seem a misuse of terms to call the grinding shriek of a tramway car as it turns a corner a musical note, but though unlovely it has something of that quality, and so must be caused by repeated vibrations. To those unaccustomed to associate such sounds with the presence of a uniform vibration the curiously regular flutings so often observed on the surface of tramway rails remained a mystery, and were provocative of all sorts of far-fetched explanations which merely confused the issue. A long discussion on "roaring rails" on railways went on at intervals during many years in our premier engineering institution, while, oddly enough, at the same time the subject of the "corrugation of rails" was chronic in another. Internal evidence from the proceedings of both societies shows that the phenomenon, though known by different names, was one and the same, although the aspects of the two societies were different. In the tramway case it consisted in the appearance of certain bright patches on the surface of an otherwise neutral-coloured steel rail—patches which indicated the development of peaks and hollows on it, which were certain to lead to its early suicide, causing much grief and expense to its masters. On the railways, on the other hand, it was the noise that attracted attention. Each time a train ran over certain sections of the line it roared as if the brakes were on, and worse sometimes. Passengers complained, and the careful permanent-way engineers were even more annoyed than the noisy oyster. I first became interested in the phenomenon when travelling daily from Bushey to Euston in 1907. After studying the rails at various parts of the line, and obtaining permission of the Company, I went out one fine Sunday with a genial foreman platelayer armed with some long rolls of tracing paper about two inches wide to obtain tracings of the markings on the rails which roared. These direct tracings have been transferred to this wall diagram on their full natural scale, and although they were done eight years ago, you are the first audience to see them.

At first sight the markings appeared to be hopelessly irregular, and gave no clue to their origin; but on looking more closely I found a characteristic form repeated itself with slight variations at definite intervals—an almost certain sign that the corrugations had their origin in vibrations. Look, for instance, at the rail marked (A). First you see a row of small bright patches at nearly regular intervals of about an inch; then follow three or four longer and less regular marks; and this complex pattern of smaller and larger markings is repeated again and again along the rail at intervals of about two and a half feet. Now, the longer markings occur on the portions of the rail near its points of support—the chairs—and the shorter ones in the interval where the rail is free: thus, every time a wheel passes over the rail it dances along the unsupported part, and then skids in longer jumps up the minute slope to the chair and over it, repeating the whole performance at every successive sleeper. I have observed miles of this pattern on the London and North-Western line and on others of our best-laid express lines. This observation at once disposes of the suggestions which have been made that the corrugations might be due to soft spots in the metals or to uneven rolling during manufacture, for it is quite beyond all probability that the rails should be soft at regular intervals corresponding to those between

sleepers, and then in so complicated but definite a pattern.

I have also observed that "roaring" rails on railways and "corrugated" ones on tramways occur almost always in places where the conditions are unusually favourable to the production and repetition of a particular vibration. Such conditions are: (1) a tendency for the wheel to slip intermittently instead of rolling—*i.e.* a moderate tangential force between wheel and rail, so that the wheel acts like a bow on a violin string or the exciting stick on one of Gould's bars; (2) a repetition of these conditions of motion for every wheel passing the section of track. Thus the worst corrugation in tramways is generally found on curves, and on these both conditions (1) and (2) exist, for (*a*) the difference in distance travelled by the outer and inner wheels on any axle in rounding a curve involves slipping of the wheels, and (*b*) the fact that there is very rarely a stopping-place on a curve ensures that every car goes over the section at nearly the same speed, unless, indeed, the other traffic is so heavy as to cause frequent delays. Conditions (1) and (2) occur also just before and just after stopping-places, and there also one often sees corrugation, even where the line is straight.

On railways I find that the same conditions are fulfilled on the sections giving most trouble. Where the rolling-stock of nearly every train is of the same type and the speed nearly the same for all trains, it is clear that the vibrating masses and their motions are alike; and I find that it is just in these circumstances that the markings which indicate the roaring rail appear most frequently. Thus on the fast lines of a four-track main line, and particularly where one express train of long bogie carriages follows another at almost exactly the same high speed with the brakes on, corrugations often occur, though these do not appear on the slow lines in the same section. On the latter the rolling-stock is of many descriptions, from passenger coaches to all types of goods and mineral waggons, and the speeds are as various: on them, therefore, the conditions for a definite vibration and its repetition are absent. If a corrugated rail be moved to another section of the track it is not uncommon for the markings to disappear, which, of course, is a further proof that the corrugations are due to a combination of circumstances favourable to vibration and not to irregularities of manufacture. The consideration of a large number of observations on tramways and railways in various parts of the United Kingdom has thus led me to the conclusion that roaring, or corrugated, rails are initially caused by vibration, and, once commenced, the corrugation naturally increases with time, since every wheel that passes deepens the hollows and renders more energetic the vibrations of all that follow.

RUSSIAN ASBESTOS INDUSTRY.

Asbestos is found in insignificant quantities in the Caucasus and in Siberia, but about 99 per cent. of the Russian output is mined in the Ural Mountains. Some of the best asbestos mined in the Urals is produced at mines sixty miles north-west of Ekaterinburg, in a zone of serpentine rocks which extends about six miles and is about 1,400 yards broad. The quality of this asbestos is believed to be as high as that of Canada and Piedmont. The veins are directly broken off, either by hand or by a hard hammer. The operation of mining asbestos in the Urals is of a primitive character, but in some cases the production is being made more systematic.

According to a report by the United States Consul-General at Moscow, the most important of the Ekaterinburg asbestos mines are the Voznesensky and Zoe-Anonsky asbestos mines, situated nineteen miles from the station of Bazhenof, on the Perm-Tiumen Railway. A third of the asbestos produced in the Urals is obtained here, and all the asbestos produced was dispatched abroad, untreated, through Reval. The Shchougy asbestos mines in the village of Mostovsky produce less than the above mines, all the asbestos produced being worked up in the factory, where sheeting, bands, twine, insertion, thread, etc., are made. The Gavorikhinsky asbestos mines lie in a line with the Voznesensky mines, and yielded 3,183 tons of asbestos in 1911. Six miles from the Meivo-Shaitansk factory of the Alapievsky Mining Works are the Kirtanovsky asbestos mines, with a sorting factory where 2,000 tons of asbestos can be sorted per annum. Close to these mines are the mines of the Russo-Italian Asbestos Co., the N. V. Mikhanov Co., the "Uralite" Co., etc. The following figures show the output of the Ural (Ekaterinburg) asbestos from 1906 to 1913: 1906, 8,001 short tons (of 2,000 lb.); 1907, 8,743 short tons; 1908, 10,694 short tons; 1909, 13,129 short tons; 1910, 10,936 short tons; 1911, 15,872 short tons; 1912, 16,584 short tons; 1913, 16,661 short tons. Practically the whole of the output was exported *via* Riga.

North of Ekaterinburg asbestos is found in the Bogolsof mining area, in the Kortiakovsky mines (where the vein is about 2 ft. thick), near the Alapievsky works, the Veniansky works on the River Uktussa, near the Beresovka works, etc. In the Southern Urals asbestos

deposits are found at the Khristogor and Petropavlovsky ore mines, near the Miask works on the River Krasnacht, in the Pavrilof copper mines (of excellent quality), in the Atliansky gold placer, near the River Imian Yurt (in talcous schist); there are veins of asbestos near the Kisnikaievsky copper mine at the foot of the Naralinsky Hills; also amongst the serpentine of the River Kara, near the Kachinsky factory, and along the River Puberle, near the fort of that name.

The best mineral is considered to be that of the Asbestovoy Hill, on the River Sissert, and the asbestos deposits of the Shelkovoy Hill, on the land of the Nizhni-Tagil works, between the Shouralinsky and the Teploy Hills. To the south of the Ural range of hills in the Government of Orenburg there are some exploited asbestos mines—the Natalievsky in the Upper Ural district—the Issergansky in the Orsk district, and the Kholmisty in the Troitzk district.

The following companies have joined the syndicate of Ural asbestos producers:—

	Tons.
1. Voznesensky Asbestos Mines, with an annual output of	3,106
2. Yakovlev Successors, with an annual output of	1,806
3. Poklevsky-Kozell Successors, with an annual output of	5,416
4. Korievo Asbestos Mines, with an annual output of	2,709
5. Girard de Soukanton, with an annual output of	3,611
6. Russo-Italian Asbestos Mining Co., with an annual output of. . . .	1,806
Total . . .	18,454

It is stated that all the companies operating in this district are privately owned and managed. The present transport facilities from the mines are confined to the single-track line of the Perm Railway, connecting with the Northern Railway to Petrograd.

According to official statistics, the exports of asbestos from Russia for the last seven years were as follows: 1909, 9,160 short tons; 1910, 9,689 short tons; 1911, 13,524 short tons; 1912, 15,547 short tons; 1913, 13,669 short tons; 1914, 8,577 short tons; 1915, 975 short tons. These exports before the war went to Germany, Austria, the United Kingdom, Belgium and the Netherlands. Asbestos is produced in the Caucasus in an insignificant quantity, in the Sharopan district of the Kutais Government, at the Vzhinevi asbestos mines. In the same Government of Kutais asbestos is known to exist far from the deposits already named to the north-west, in the Lechgoumsky district in the Savanetsky police circuit. It is also found in the extreme south-eastern corner of the Caucasus, not far from the Persian frontier, twelve miles from the town of Shusha.

In Siberia asbestos is exploited only in the Government of Irkutsk, in the Angar district, at the Angar asbestos mines. In the Government of Yenisei there are asbestos mines on the left bank of the River Kamuisht, near the Saksar and the Ak-kay Hills, near Bishtals Hill, at a distance of twenty-five miles from the village of Askeisk, and on the River Karagan, on the boundary of the Mausky and the Servievsky gold placers. In the Tomsk Government it is found in the system of the River Katum, in the Semiriechensk territory, on the northern slope of the Dzhigla Range, in the Dzuban-Arychsky district, and in the Transbaikal Province, in the serpentine of the Klinchinsky ore mine, near the Shilkinsky factory, and in the neighbourhood of the tin mines of the Nerchinsk Circuit.

On the Mongol-Dabansky gold placers (now worked out), which belong to the Crown, very rich asbestos and mica mines have been discovered. The Mongol-Dabansky gold placers are situated on the River Mongol-Daban, which falls into the River Didi, a tributary of the River Oka. The new mines lie seventy-five miles from the station Zima, on the Trans-Siberian Railway.

HOG-RAISING IN CUBA.

Cuba consumes more than £2,000,000 worth of pork and pork products per annum, but as yet there has been no sustained effort to raise pork for the local demand, or to establish a packing-house industry, although the country is in many respects ideal for raising hogs. There is an abundance of water, forage all the year round, an equable climate, and, in addition, the widespread distribution of the royal palm tree ensures a great quantity of the seeds, called "palmiche," which fall at all seasons of the year and are greatly relished by swine. The palmiche gives the meat a nutty flavour that is very fine indeed, and pork raised on this food is held in great esteem. The animals thrive on it amazingly.

In addition to the palmiche there are other foods growing wild—the guava, which hogs relish, and yuca roots, and many other tubers and roots. Mango trees are distributed over the island, and in season the ripe mangoes that fall are a considerable factor in the food supply. Sugar cane is eaten with avidity, and is found to be remarkably satisfactory for putting flesh on hogs. Cow peas, peanuts, sweet potatoes, soya beans, and the like as special forage and grazing crops grow with little attention. Good land suitable for hog-raising may be had for 10*s.* 6*d.* to £2 per acre, becoming more expensive as the location is nearer the cities.

The native hog in Cuba is very much like the famed "razorback" of the Southern pine woods —mostly head, legs, snout, and ears, swift of foot, but very hardy and thrifty, and does well without any care whatever. According to a report by the United States Special Agent in Cuba, there is as yet practically no effort to raise hogs commercially, except in small herds which range the woods in charge of a herdsman and his dogs. The meat of these semi-wild hogs is in considerable demand on account of its flavour from the palmiche seeds, but the supply is not dependable, and no attempt is made to put it up as hams, bacon, ribs, or sides. This fresh pork sells at 4½*d.* a lb. all the year round, and is scarce at times.

There has of late grown up in Cuba a sentiment in favour of producing more foodstuffs, and hog-raising is receiving considerable attention. The Cuban Agricultural Experiment Station at Santiago de las Vegas is experimenting with various breeds, and is in touch with the more progressive element which intends to devote attention to the growing of better pork. Cholera is known to some extent, but the most prevalent disease with which Cuban hogs are afflicted is called "pintadillo," and is supposed to be a mild sort of cholera. The Cuban Experiment Station is now seeking in the United States a competent chemist to make cholera serum and to study the diseases of native hogs.

In 1913 Cuba imported 10,225 hogs, valued at £26,170, and in 1914, 9,816 hogs, valued at £26,920. The United States furnished the entire number. Duroc-Jerseys, Berkshires, and Poland Chinas appear to be the favourites, and a cross between these and the native hogs produces a thrifty animal which, if not ideal in shape from the packing-house standpoint, carries considerable meat, and is a great improvement on the native wild hog.

Some capitalists of the United States are now projecting a hog ranch and packing-house on 20,000 acres of land in Pinar del Rio Province, about sixty miles from Habana. It is proposed to commence with a capital of £50,000.

OIL-ENGINES IN HONG-KONG.

In spite of the general depression of trade noticeable in all lines, and especially in those lines of trade which depend directly upon Chinese consumption, there seems to be a continued demand in China for internal-combustion engines of several varieties and especially for marine motors. The growth of the trade in normal years has been remarked upon by nearly all trade authorities, the Commissioner of Customs at Canton, in his recently published annual report, saying, for example :—

"The demand that is becoming noticeable for oil-engines, both stationary and marine, is due chiefly to recent improvements in motors permitting the use of crude oil in place of the more expensive gasoline, and a large development of this trade in the near future may confidently be predicted. Crude-oil motors for irrigation purposes were erected during the year in the Ko Ming district on the West River, near Samshui, and larger engines of similar type were also imported for the use of the Fatshan Electric Supply Co. Oil-engines, usually an exact copy of some foreign pattern, are being made locally by the Chinese engineering firms, who are presumably alive to the growing demand for motive power in a handy form."

From a recent report by the United States Consul-General in Hong-Kong, it appears that the manufacture of such motors in Canton, or elsewhere in China, so far has not developed to any considerable extent, nor is it likely to do so for some time to come so long as prices of imported motors are reasonably low. The use of motor pumps for irrigation along the West River has not been very successful, though the outbreak of the war in Europe and the collapse of South China's foreign trade have prevented a fair test of the demand for engines for such purposes.

The war has also directly affected the development of the motor-boat traffic on South China rivers by causing the depression which has existed for months in all lines of Chinese activity. Nevertheless, the trade has continued in fair volume, and with the advent of normal conditions in this field the demand will increase greatly. The type mostly in demand is a simple motor with few working parts and an ability to stand exposure, dirt and neglect, and using crude oil or petroleum as fuel. The demand is mostly for marine motors and motors suitable for small electric light and power plants, and for running very small industrial establishments.

MARBLE DEPOSITS IN BRITISH COLUMBIA.

Among the many natural resources of British Columbia available for commercial and industrial purposes is a fine grade of marble. An extensive ledge of what is designated as Malaspina marble is now being worked on Texada Island, about fifty miles north-west of Vancouver. It is a crinoidal formation, its most attractive feature being the variety and extent of tints and colouring shown in irregular streaks.

Marble from the Texada quarries was used for decorative purposes in the new Vancouver Hotel, completed in 1915, and samples exhibited at the Panama-Pacific Exposition at San Francisco attracted favourable attention. The deposits are found in the southern end of the island adjacent to a land-locked bay, which facilitates the transportation of the product to markets on the mainland.

The value of marble imported into Canada in recent years has averaged about £100,000

annually. In addition to the imported article, marble from Canadian quarries, particularly the green marble of Missisquoi, is extensively used throughout the Dominion. According to a recent report by the United States Consul-General at Vancouver, it is estimated that the marble used in buildings in Vancouver has a total value of £1,000,000, and with the rapid development of the country the prospects for the development of an important industry in the quarries of Texada Island are promising.

ENGINEERING NOTES.

American Gasoline Caterpillars for Drainage Purposes.—The latest development in ploughs for excavating drainage channels of sizes too small to be economically handled by a dredge is the gasoline traction engine, mounted on caterpillars. Many years ago a drainage channel plough was invented. Horses were attached four abreast, and frequently 50 miles of channel 8 ft. wide on top, 3 ft. deep, and 18 in. at bottom width, were let on contract prices at from 5*s.* 2*d.* to 8s. 4*d.* per rod. The gasoline machine which is replacing these outfits consists of an engine supported on two long caterpillars 30 in. wide, which carry a 16-in. diameter cable drum 24 in. long. This drum is driven from the main shaft of the 60-h.p. engine, and is geared to give a rope speed of 14 to 18 ft. per minute, depending on the amount of cable on the drum. About 1,000 ft. of 1⅝-in. wire rope is used. When, on account of difficult ground or for other reasons, the tractor must be set at greater distance from the plough, removable lengths of 500 or 600 ft. of wire rope are attached between the plough and the end of the cable. In operation, the plough, removed from its four-wheel carriage, is left at the starting-point of the channel, the cable attached to its beam. The tractor moves ahead to the proper point on the line of the channel, paying out the cable as it advances. The traction gear is then released and the drum thrown in. As soon as a strain is taken on the cable, two anchor flukes drop to the ground and bite in as the tractor moves backward until the latter is securely anchored. When the plough is drawn to the end of the cut, the drum is thrown out of gear and the tractor thrown in. As the tractor advances, the anchors ride up from the ground and are hooked up in the clear by power. One man and a helper are required to operate the tractor, while another man rides the plough. A team and driver are employed in hauling supplies, and a cabin on wheels, presided over by a cook, furnishes food for the crew. The plough, weighing 4 tons with its removable truck, a waggon loaded with cable and supplies, and the cook waggon are hauled by the tractor over ordinary country roads at the rate of two miles per hour. Although the tractor weighs 15 tons, its large bearing surface enables it to travel over swamp land too soft to support a team. A plough of increased size, which will cut drains 2 ft. in bottom by 9 ft. in width, and 3 ft. 6 in. deep, is used with the tractor. The caterpillars are similar to those that have been applied to the so-called "Tanks" for war purposes.

Niagara Wire-Rope Way.—A passenger cable-way, said to have the longest clear span in the world, has recently been built across the Niagara Whirlpool, at a cost of about £15,000. The passenger car is suspended from a running gear which travels on six parallel track cables of 1 in. crucible steel rope. Each cable is anchored securely at Colt's Point, the starting point, by means of a 2-in. rod bent into an anchorage in a 740-ton concrete block. At the other terminus each track cable passes over a sheave and is fastened to a counterweight or stretcher. Boxes, 12 ft. high by 6 ft. 7 in. wide by 11 in. deep, made of riveted steel, contain cast-iron weights sufficient to make a total of 10 tons for each track-cable counterweight. The boxes move up and down freely in steel guides, maintaining the tension in each cable always at 10 tons regardless of the load on the cables. When the load on the car is increased, the counterweights rise, and sag in the cables is increased until they take such an angle that the sum of the vertical components of the tension at the ends is equivalent to the weight of the car and its load. Each track cable is entirely independent of the others. The breaking of any one of them would not be serious, as the other cables would support all the weight of the car without any increase in their tension. The car would drop several feet suddenly, and, after a few vertical oscillations, would assume a new position of equilibrium. Thus the breaking of one cable would not imperil the passengers, and the breaking of two cables at the same time would be very improbable. The car seats twenty-four passengers and provides standing room in a raised aisle in the centre of the car for twenty-two more, including the conductor. The weight of the car when empty is 3½ tons, and when fully loaded 7 tons. It is 10 ft. 10 in. wide, 24 ft. long, and 23 ft. high. The car is propelled by a ⅝-in. plough steel traction cable fastened to one end. The cable passes over a sheave on Colt's Point, runs back across the whirlpool, over a sheave in front of the Thompson's Point station, the other terminus, and to the driving sheave. From here it passes around three sheaves, to one of which is fastened a 10-ton counterweight box arranged in guides similar to those for the track-cable counterweights, thus creating a tension in the cable which adjusts any slack caused by the rising and falling of the car. The 8-ft. driving sheave is turned by a 75-h.p. Westinghouse motor, through a 30 to 1 worm gear, giving a speed to the car of about 400 ft. per minute when the controller is at full speed. The trip can be made in about 4½ minutes, but it is planned to permit it to occupy 6 minutes by running at half-speed part of the time. To provide against a breakdown of the motor or interruption in the power supply, there is a clutch in the driving shaft, by means of which the motor can be disengaged

and a 5-h.p. gasoline engine engaged both through a worm and through socket wheels. An automatic control stop is provided in each terminal, which stops the car without jar within a distance of 3 ft. 4 in. The traction cable runs longitudinally through the 5-in. pneumatic cylinder and through the centre of the piston. A clamp on the traction cable, just ahead of the car, strikes the face of the piston and also engages with it in such manner that the car cannot slip back from the landing platform. After the traction and track-tower sheaves had been erected, a very long rope was carried around the face of the cliff from Thompson's Point to Colt's Point. This rope was then hoisted over the tops of the trees until it could be pulled taut from point to point. A ½-in. wire-rope was pulled across with the aid of a hoisting engine, and then the ⅞-in. traction cable was pulled into place. The traction cable was used to haul the track cables across. The strength of the track cables is 92,000 lb. each, allowing for bending over the sheaves, and the working tension is 20,000 lb., so that the factor of safety is 4·6. The sag of the track cable unloaded is 47 ft. 6 in.; the maximum sag when loaded with car and passengers is 100 ft. The car will still be 148 ft. above the surface of the water at the point of maximum sag. The grade of the track cable varies from 16 per cent. at either landing to level at the centre of the span. The above description has been abridged from the *Canadian Engineer*.

Lancashire Water Schemes.—Both Liverpool and Manchester are now faced with the urgent necessity of undertaking important schemes in connection with their water supply. In both cases there is ample supply, at Vyrnwy and Thirlmere respectively, and the difficulty arises from the fact that the demand is becoming greater than the existing pipe lines can meet. Last year the average daily consumption at Liverpool was 40,000,000 gallons, but this would have been considerably exceeded had it not been for temporary decreases in consumption for sanitary and other public supplies. The existing pipe lines will deliver only 46,000,000 gallons, of which some millions must be deducted on account of repairs and other contingencies, and the reservoirs which must be drawn upon to meet any demand beyond the capacity of the pipe lines are relatively small, holding no more than four days' supply to the district. In these circumstances, despite the Corporation's resolution of some months ago to postpone action in regard to the laying of another pipe line from Vyrnwy, the water department is putting itself into a position of preparedness to undertake the work as soon as the sanction of the City Council and the Local Government Board has been obtained. The plight of Manchester is similar, and initial steps have been taken to construct a fourth pipe line from Thirlmere, a distance from Manchester of ninety-six miles. When the third line was ordered the consumption of water was estimated at 40,000,000 gallons, but it has passed that figure, and for manufacturing as well as general purposes is increasing so rapidly that the necessity of doing something quickly has led to the opening of negotiations with the Local Government Board. The last pipe was estimated to cost the city £832,000, and in its construction 72,000 tons of cast-iron pipe were used. The *Times* is the authority for the above statement.

The Seasoning of Concrete by Calcium Chloride.—Calcium chloride added to the mixing water to an amount of 4 per cent. by weight will increase by large percentages the rapidity with which concrete gains strength. This conclusion has been reached at the United States Bureau of Standards at Washington, in which the effects of various chemicals were studied in an effort to find a good accelerator for hardening concrete. While the time of setting was not materially affected by adding calcium chloride, there was no difficulty experienced in handling the concrete to which it had been added. Standard 1–3 mortar cubes and standard cylinders of 1–2–4 and 1–1½–3 concrete were tested in compression at varying ages up to thirty days. Tests of the 1–3 standard sand mortar show that the rate of hardening is accelerated most by the addition of calcium chloride, which increases the strength at twenty-four hours by from 155 to 230 per cent. and at forty-eight hours by from 173 to 190 per cent. over the strength of mortar containing no calcium chloride. The best percentage of calcium chloride to use for proportions of concrete is from 3 to 4 per cent. of the weight of the mixing water. The increase in strength at forty-eight hours thus obtained varies from 14 to 275 per cent. for the 1–2–4 mix and from 11 to 110 per cent. for the 1–1½–3 mix. In all but one case the concretes mixed with 4 per cent. of calcium chloride show greater strength for both mixes than for plain concrete, these results being consistent, though variable, for all the ages tested, up to thirty days. This acceleration in strength is believed to be due to the more complete hydration of the silicates and aluminates in the setting of the cement. The use of calcium chloride increases the cost of concrete by 2*s.* to 2*s.* 6*d.* per cubic yard. For best results it is important that the concrete be mixed to a quaking, but not fluid, consistency. Calcium chloride should be used with caution for reinforced-concrete construction, as it tends to accelerate any corrosion of the steel which may occur.

United States of America Government Nitrogen Plants.—According to the *Electrical Review and Western Electrician*, Congress has passed a Bill authorising the development of hydro-electrical power for the electrical fixation of nitrogen, which will be used in the manufacture of munitions of war, and thus make the Government independent of imported nitrates for this purpose. The President is authorised to cause an investigation of the

best means for producing nitrates, etc., by water or other power; to obtain exclusive use of any necessary site for the purpose of the Act; and to provide the necessary equipment, etc. Any surplus product may be sold and disposed of, and may be used in the manufacture of fertilisers. The sum of twenty million dollars is appropriated for the scheme, which will be operated solely by the Government, and not in conjunction with any other industries or enterprises carried on by private capital.

GENERAL NOTES.

Newfoundland Cod Fishery.—The prospects of the present season, according to *United Empire*, are as favourable as any in the island's history. The catches made on the Grand Banks have been somewhat above the ordinary, the shore fishers are doing well, while the reports from Labrador are also satisfactory. This is all the more gratifying because the fishermen are assured of good prices for their fish, owing firstly to the small catch made by the Norwegians this year, and secondly to the greatly increased demand for fish in all parts of the world as a result of the interference with normal conditions due to the war. Buyers from Canada, America, and France are now making contracts for supplies of cod, and in addition there is a very promising outlook for the sales of cod-liver oil. The Norwegian cod fishery has yielded this year about 44,000 barrels of oil, as compared with 48,000 last year. In 1915 the stock was bought by Germany, and used to obtain glycerine for explosives. This year it has been purchased by Great Britain and France. The withdrawal of Norwegian oil from commercial circles will offer a great opportunity to Newfoundland, and dealers are now taking steps to cope with the demand. Some 400 licences for the manufacture of medicinal cod-liver oil have been issued in Newfoundland this year under the terms of a new Act which provides for the Government control of this industry with the object of securing the production of an article equal, if not superior, to the Norwegian oil. At present the price of this oil, which used to average about $10 per barrel of twenty gallons, is about $2 a gallon.

Electro-Chemical Industries in South Africa.—The Development of Resources Committee of the South African Institute of Electrical Engineers have issued a report on the possibilities of establishing in South Africa, on a commercial basis, certain electro-chemical industries. At present the two chief industries of the country, agriculture and mining, require annually more than £2,000,000 worth of chemicals, all of which are imported in the form of fertilisers, cyanide, and nitrates. In order to manufacture these substances successfully, the chief essentials are cheap electricity, abundant coal, limestone, and labour, all of which may be had in South Africa. The report then considers the question of manufacturing certain specific compounds, and concludes that they can be made profitably provided the raw materials are obtainable at reasonable rates. The prospects of starting these new industries appear to be promising, and it is hoped that the report may stimulate activity in this direction.

London Fog and Smoke Deposits.—The City of London Medical Officer, in his report for 1915, states that during the year 1914, with the concurrence of the Sanitary Committee—in conjunction with the Committee for the Investigation of Atmospheric Pollution, appointed by the International Exhibition and Conference in London, 1912—a critical examination of the air in the City was commenced. An apparatus consisting of a large rain-gauge was placed in a convenient position upon the roof of the shelter in Golden-lane, and the rainwater from a known area of surface was collected monthly. This rainwater, containing the soot, grit, and dust washed from the air, has been submitted for examination to the Public Analyst and the results tabulated. A table is given showing the rainfall for 1915, and the amounts found of insoluble matter, tar, soot, and dust, also the soluble matter, together with the sulphates, ammonia, and chlorine in the volume collected. The results as given by the Public Analyst have been recalculated into metric tons per square kilometre during the month. One metric ton per square kilometre is equivalent to approximately 9 lb. per acre or 2·56 tons per square mile. In the month of November only the amount of deposit registered as falling in the City amounted to 21·48 metric tons per square kilometre, which is equal (estimating the City as an area of one square mile) to no less than 55 tons avoirdupois. Of this mass of dirt nearly 35 tons were soluble and included the chemicals mentioned, and 20 tons were insoluble and consisted of tar, carbon, and grit. In addition to the foregoing a daily observation has been made at midday at the Guildhall of the purity of the air by a new dry method by which the suspended matter can be readily demonstrated. The amount of the impurity at noon has varied from a trace to three milligrams per cubic metre of air. This includes times when there has been a slight fog, but no dense fog has yet been tested at the Guildhall.

French Helmets.—Over 3,500,000 helmets have now been made for the French army. They are stamped out of the best sheet steel. Each helmet is made up of four pieces—the cap, the peak, the neck-protector, and the crest; and they are riveted together and sprayed with a grey-blue paint, just sufficient to prevent rust. A helmet requires about 2 lb. of steel and a little aluminium to stiffen the lining.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

VIBRATIONS, WAVES AND RESONANCE.

By J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E.

Lecture III.—Delivered May 15th, 1916.

In my last lecture I gave you some concrete examples of waves in ponderable, or ordinary, matter. I am well aware that in a single hour it would have been difficult to describe even any one of them in thorough detail and quite impossible to have gone mathematically into its particular form of motion; hence I have chosen rather to give you these merely as illustrations of the general laws, and have emphasised their similarities instead of dwelling upon their differences. I have followed, in fact, the plan which I laid down in my first lecture, of treating the subject from the point of view of Natural Philosophy, a plan which indicates that before one can usefully employ the symbols and processes of mathematics one must have a clear conception of the phenomena and of their fundamental laws. This was the method of Sir Isaac Newton, whose great propositions, stated in the plainest of language, form the basis of all modern dynamics. It might be well if our modern mathematicians would bear this more constantly in mind in attempting the solution of physical problems.

To-day our subject is Ether Waves, that is to say, the waves which are called electric, and those of light and heat. Owing to necessary restrictions in time of war I am unable to experiment with the longer waves such as are used in radiotelegraphy; but this may, after all, be a blessing in disguise, for, as ether waves travel at an enormous speed and are usually invisible and always inaudible, it is really better that I should have to demonstrate their laws and properties by mechanical illustrations which you can see and appreciate. These illustrations are not mere analogies, but are simply other examples of the same law. When, for instance, I show you the attenuation of a wave, it is in illustration of an important law of wave motion, and not merely of a particular phenomenon in submarine-cable signalling, telephony or fluid motions; the demonstration is, in fact, a moving picture in which the one thing conspicuously obvious is the law under consideration.

I shall not attempt to go into the question of the molecular nature of electricity since it hardly concerns us in a general survey of wave motions, and shall speak of charges of electricity and their conduction as mere facts, without giving an electronic or other explanation. I do not mean to imply that the theory that electricity moves as a number of small discreet particles is untrue, but only that for our purposes the ultimate nature of its structure is unimportant, the mass result being that with which we deal.

Now I must say something which may appear paradoxical but which is nevertheless true. An electric wave is a moving state of stress in the ether which may cause the motion of electricity in a conductor, but is not itself the motion of an electric charge. For some purposes it is convenient to look upon this changing electric stress, or displacement as Clerk-Maxwell called it, as an electric current, but it is not in itself the motion of a charge of electricity; in fact, completely closed moving rings of it may exist in a medium which is wholly non-conducting. There are, therefore, both free electric waves which travel unguided through a non-conductor, and conducted waves which are guided by a conductor. The electric stress is of the same kind in both cases, but the presence of a conductor profoundly modifies the nature of the wave motion. Suppose that we create a series of electric waves, the wave-length being a few metres as in Hertz's experiments. Such waves in uniform free space will travel in straight lines

outwards from the point of origin; but attach them to a conductor and they will follow it even round the convolutions of a coil of wire a few millimetres in diameter. Again attach them to the earth, as at a wireless station, and they will follow its surface over hill and dale and over the waves of the sea. I do not say that a mountain in their path makes no difference, but experience has shown that it in no sense casts as perfect a shadow as it would do if the waves travelled in straight lines, even allowing for the inward bending of the rays usually called diffraction. We must not, however, consider a conducted wave as something essentially different from a free one; it is not, it is just literally a wave conducted, *i.e.* guided by the surface of the conductor.

In the material of the conductor itself the wave has no longer the simple nature it has outside. As it penetrates the surface it generates conduction currents, and energy is used up in driving these. Also the better the conductor the less stiff is the dielectric in it and the smaller the depth to which the waves penetrate. In a good conductor, such as copper, the generation of the current commences very evidently at the outside, and when a constant E.M.F. is applied along the surface it is, comparatively speaking, a long time before the flow becomes uniform, even to a depth of a few centimetres. The process is in reality one of diffusion, not radiation, and the establishment of the steady state of the current is a matter of several seconds. Thus it is that we have what is called the "skin effect," that is to say, the limitation of the major part of an alternating current to the outer layers of a conductor, *i.e.* to those in contact with the dielectric.

It is important that you should realise the fact that the energy in electrical actions travels *viâ* the dielectric or non-conductor. This is quite clear when we are dealing with free radiation, but not so obvious for conducted waves or for the limiting case of an infinitely long wave which we call constant, or direct, current. It has been proved mathematically by the late Professor Poynting, in an investigation which is fundamental to modern theory but which is too elaborate to give you here. Instead, I shall ask you to consider a simple experiment from which the same deduction can logically be drawn. Suppose that I am in a small room with continuous walls of solid copper a foot or more thick in which there is no crack or opening whatever. Outside the room there is a dynamo or other source of electric power; inside it I have an ordinary electric lamp which I wish to light from the power outside. How can I do it? There is no use soldering both terminals of the lamp to points on the inside of the walls and those of the dynamo to points on the outside, for the walls are thick copper and the difference of potential between any two points on the outside, and still more between those on the inside, will, as you know, be utterly infinitesimal. No, if I want to get the energy in there is only one way to do it, and that is to bore a hole through the copper and run an insulated wire through it to the lamp. The material of the insulation is of little consequence, the essential point being that there must be a continuous tube of insulator from the dynamo through the wall to the lamp. This is a direct proof that the energy travels *viâ* the insulator, and it is at once simple and logically convincing.

It is for this reason that the stresses, whether constant or varying, in a dielectric are of such great importance: they are the means by which electrical energy moves from place to place and fulfils its manifold functions; a conductor may guide, but it does not convey and without a dielectric is useless.

A similar law holds in mechanical things. Suppose we have a large pond into which a jet of water is projected horizontally from a pipe at one end. No appreciable energy will reach the far end, even though the flow from the pipe be of considerable velocity. But if instead of allowing the jet to diffuse itself and mingle with the mass of water in the pond we contain it by making it flow through a hollow cylinder of some material which can permanently support an elastic stress—if, in fact, we continue the pipe across the pond—we shall obtain the energy at the far end in almost its full amount. The pipe, or insulator, has conveyed it along its solid walls.

In order to eliminate the mysterious force called gravity, I have supposed the pipe to be horizontal and uniform in diameter; this being so, there can be no steady flow of water in the pipe unless there is a tension in the walls of the pipe, and more than this, there can be no flow unless this stress decreases along the pipe in the direction of flow.

The flow of electric current in a submarine cable has many points in common with that of water in a pipe. The dielectric, for instance, is a hollow cylinder filled with, and surrounded by, a conductor just as the pipe is surrounded by and filled with a fluid, while its thickness and its electrical rigidity, together with the resistance of the conductor in its core, control the amount

of current under any given difference of pressure between its ends in the same way that the flow of water in the pipe is controlled by the rigidity of the walls and the viscosity of the fluid. Indeed, so similar are the phenomena when considered as questions in the flow of energy that it is possible to employ the one as a useful working model of the other.

On this horizontal board I have laid a thin-walled rubber tube of 4 ft. or 5 ft. long; it is filled with a mixture of syrup and water, and you can see a drop hanging from the far end over the bowl. At the near end the tube is fixed on to the jet of a strong syringe, also filled with the same liquid. Now I press the piston of the syringe firmly and raise a bulge in the tube. The swelling creeps along, but not till it comes to the far end of the tube does any liquid run out. Now this is a true picture not only of the flow of electricity in a submarine cable, but also of the flow of water in any level pipe. In it, however, I have chosen the dimensions and materials so that the time factor is, as it were, magnified. Where the bulge takes several seconds to travel along the rubber tube, it would have flashed from end to end of a steel pipe of the same size in a minute fraction of a second; also it would not have been of visible size for steel is so much stiffer than rubber — but it would have happened all the same. In an electric cable of the same length as the tube the motion would have taken place even more rapidly, indeed the tube represents in this respect a cable of several thousand miles in length.

Note that the moving bulge is a true wave or impulse, not merely a mass of material moving forward, and that in fact the liquid which I put into the tube from the syringe remains at this end, and that the movement of any particular drop of liquid is merely a small distance forwards and outwards as the pressure rises behind it. The pressure travels the whole length of the tube, but the liquid only takes one short step. We have, therefore, a true wave or impulse swelling along the tube. To make the phenomenon obvious to those of you who are not close at hand, I have mounted a number of little flags on wires which are attached to the board at their lower ends and lie across the tube. You see that each flag rises as the bulge reaches it, and that it falls again shortly after. Now this model is very like the electrical case. The elasticity of the rubber walls of the tube is the capacity between the core of the cable and the sea water outside it; and the resistance due to the viscosity of the liquid is the electrical resistance of the core. In neither case is the inertia important, as the motion of the liquid is so slow that it is almost completely dependent on resistance of the liquid and elasticity of the tube, while in the cable the only factors of serious importance are the capacity and resistance. To follow the similarity you have only to recollect the picture I made for you in the first lecture, in which I showed the action of a condenser in terms of an elastic solid in which were cavities containing liquid. In this case, however, the solid is not an infinite mass but is merely a hollow cylinder surrounded by, and filled with, liquid. The greater the capacity, *i.e.* the thinner the walls of the tube, the slower does the impulse travel, and increase of resistance, whether fluid or electrical, produces a similar effect.

The frequency of the waves used in cable telegraphy is about ten per second, and, as the time that an impulse takes to travel from Ireland to Newfoundland is a large fraction of a second, there are several waves on their way along an Atlantic cable at one time.

Waves of all sorts gradually die out as they progress through a medium along a conductor, and short ones do so more rapidly than those of greater length. Technically this decrease in size is called attenuation, and when a compound wave travels its shorter components become more rapidly attenuated than the longer ones. Thus, in a telephone conductor the higher harmonic waves which define the vowel or consonant sounds, as I explained to you in the first lecture, are more reduced in proportion than the fundamental wave. The result is that, although a voice may sound quite loud at the far end of a long line, it may have lost its character, and it may be difficult to distinguish between such sounds as "ee" and "oo." This is the reason why as yet telephony has never been carried out through submarine cables of any considerable length, for in a cable the largeness of the capacity, providing, as it were, a shunt circuit to the sea, causes great attenuation. Even in underground cables, such as, for many good reasons, we have in London, the capacity is much greater than between the wires of an overhead circuit, and it is possible that this is one reason why the telephone operators are instructed to roll their "r's" in a triumphant "thr-r-ree," instead of pronouncing them in the ordinary way. One would not naturally expect that "three" and "two" could be confused, as they sometimes are, but when one

considers the wave forms of "ee" and "oo" one understands the reason. The sound "oo" is practically a perfect sine wave, while "ee" is a similar wave with five small ripples on it. If these disappear there is only "oo" left, and "three" becomes very like "two."

Now I shall show you the attenuation of waves and the distortion, or loss of character, of a complex wave as it progresses. Here is a long piece of the light fabric called butter-muslin, with wooden stretchers across its ends, one of which is attached to the picture-rail on the wall. Holding the stretcher at the free end of the muslin in my hands, I pull it gently towards me until the fabric is pulled up almost to a horizontal plane. Now I move the end of the muslin slowly but steadily up and down, and you see large waves travelling slowly along it towards the wall, which they just reach. Next I make the up-and-down motion much more rapid, and although I am actually giving out more energy than I did when making the long ones, the short waves produced die out long before they have traversed the length of the muslin, and indeed are quite imperceptible beyond a distance of a yard or two; thus the attenuation of the short wave is very much greater than that of the long. Here you have the reason why long waves are preferred to short in long-distance telegraphy of all kinds.

If now I send out both types of wave at once by moving my hands up and down with a rapid vibration superposed on a slower one—in what, for want of a better term, I may call a series of jerks—you see that the compound wave which goes along the muslin soon loses the ripples which give it its peculiar character, and long before it reaches the end becomes quite smooth. There you have an explanation of the difficulties of submarine telephony and, indeed, of all long-distance transmission of complex waves. Even in ocean waves the same effect is to be seen when a long, oily wave comes in over a glassy sea without a ripple on it.

There is one way to reduce the attenuation of short waves along a wire or of pulses along a cord, and that is to add inductance or inertia uniformly distributed along it. Each wave then represents a greater quantity of energy, and as the transverse motion is more rapid in a short wave than in a long one of the same amplitude, the energy is proportionately greater in the short wave than in the long one. Hence the short wave is fortified against the attenuating influence of resistance and capacity, and the complex wave travels on with less distortion. For this reason one more easily obtains "harmonics" on the wire-covered strings of a violin or guitar than on the lighter gut strings, and better articulation on a telephone cable loaded with inductance than on one with a single straight conductor. The Channel telephone cable, for instance, has extra coils of wire inserted in it at short equal intervals along it in order to make speech to Paris possible, and the same arrangement is used in some of the very long land lines in America and elsewhere. The distances between the coils must be short as compared with the lengths of the waves transmitted, so as to approximate as nearly as possible to a uniform distribution of inductance. Adding inductance of course reduces the velocity of the wave along the conductor, but as the energy is not seriously decreased this is of much less consequence than the improvement in the clearness of speech.

If a coil of very great inductance is put in series with an alternating current or telephone line, it may almost entirely prevent any current flowing. Large inductance means large storage of energy as magnetic lines of force in the medium surrounding the conductor, and the actual reflection back along the conductor of much of the wave energy. The introduction of a large inductance in a line in which the distributed inductance is small, therefore cuts down an alternating current, just as an increase of resistance would do; hence, in technical parlance, such a coil is usually called a "choker." I can show you the same wave effect on the long-stretched rope, at a point on which I have fixed a 7 lb. weight. I give one end of the rope a vigorous waggle, but although the wave runs rapidly along as far as the weight it gets no further, but returns towards my hand. Here the mass has so great inertia that the force of the wave is not sufficient to set it quickly in motion, and the rope swings over and returns before it has moved appreciably. Thus the wave is reflected and returns to the origin. In the electrical case the wave has not time to overcome the inertia of the choking coil, due to the large amount of magnetic force which has to be built up during even the smallest increase of current, and its energy is therefore also reflected back to the origin.

At first sight this phenomenon would appear to contradict the law that loading the line reduces the attenuation of waves, but it is not so. The difference lies in the distribution of the inertia. If this be added along the whole line or in small lumps commencing near the origin, there being a considerable number of lumps

each wave length, a wave starting with the same energy is more persistent, for its energy is now largely magnetic, and therefore is not wasted but is returned to the current at each half oscillation. A smaller wave current has therefore the same energy as a larger one on an unloaded line, and since it is smaller there is less loss due to resistance, and therefore less attenuation of the wave, as it proceeds.

It is a general rule that when a wave passes from a less dense to a more dense medium, some part of its energy is reflected back into the less dense medium, and that if the difference in density is very great the reflection may be nearly complete. Thus, when a wave travels along the cord to the end which is fixed to the wall, it is almost entirely reflected. There is no doubt a wave of very small amplitude in the wall itself, but, owing to the mass being so great, it is practically negligible. It is also true that when a wave goes from a stiff into a slacker medium, or *vice versâ*, there is partial reflection. If, for instance, I strike one end of a beam with a hammer, the compression wave goes along to the far end and starts a wave in air which you hear as a sound, but a good deal of the energy comes back in the beam to my end, and is again reflected internally. I can tell that this is so from the mere fact that the beam gives out a definite note, which proves the existence of a succession of waves, although I only gave the beam one stroke.

To eliminate the difference of density one might immerse the log in a liquid of its own density but of a different compressibility, which is not difficult to do, and the result would be similar to that in air.

I have lately noticed a curious case of the production of a musical note by reflection which appears to be analogous to that which one gets on clapping one's hands in a room with bare walls. If one is standing on smooth ground while an aeroplane is passing overhead one hears a rough musical note of fairly definite pitch. On bending down, however, the pitch rises, and if one lowers one's head to about half its usual height the note goes up a whole octave. The effect is very curious, and is particularly marked if one keeps on bowing continuously. A similar sound can be heard, though less clearly, under a tree whose leaves are rustling in a breeze. I noticed it first under an aspen in my garden on a quiet afternoon. The explanation seems to be that each impulse reaches the ear twice in quick succession, once while going down and once when rising after reflection from the ground; thus, though the original series of impulses is probably irregular, particularly from the rustling tree, the fact that each gives, as it were, a little double knock to the ear in passing and re-passing, and that the time interval between the knocks of each pair is the same, gives one the sensation of a musical note. It is curious to think that these definite musical tones of the forest, though heard by countless generations, do not appear to have been recognised or recorded, except perhaps in a general way by some nature poets.

Hertz's first experiments on the production of electric waves were complicated by the very same phenomenon. It is known now that when at the outset he thought he was tuning his receiver to the waves from his radiator he was, in fact, tuning to the interval between the direct passage of an impulse, and its return reflected from the wall. The frequency observed was, in fact, like the hum of the aeroplane, dependent on the distance of the receiver from the reflecting surface.

Here I may remind you of one great generalisation made by Clerk-Maxwell from his mathematical investigations of the laws of electricity. Up till the date of his work it was believed that electrical actions travelled at an infinite speed—that is to say, that a disturbance at any point in space produced its results simultaneously at all other points, however distant. Faraday had an idea that this supposition was incorrect, and tried in many ways to show that electric and magnetic actions took time to travel from place to place, but was baffled, as we now know, by the enormous speed with which he was dealing. Clerk-Maxwell, however, showed that the laws which had been proved to govern the motion of electricity indicated that an electric disturbance would travel through space with the speed of light, and that indeed light and radiant heat themselves conformed to the laws which he had proved for electric waves. For a number of years Lord Kelvin was the only scientific man of note who upheld Maxwell's view, and it was not until Hertz had experimentally demonstrated the existence and properties of electrical waves that the true significance of his remarkable deduction was realised by others.

There is an interesting and fundamental phenomenon of wave motion on which I have not yet touched—it is called diffraction. When a procession of sea waves enters a harbour between the ends of the breakwaters, it does not merely go forward like a column of soldiers marching forward in parallel straight lines

through a gate, but on the contrary the outer end of each wave, as it passes through the opening in the wall, curves round, clinging to the inner side of the breakwater, and thus stretching out the wave into a convex curve which sweeps over the whole surface of the harbour even into its most sheltered corners. Of course, the wave is largest in the direct line of its entrance to the harbour and becomes lower and lower as it curves round into the shelter, but there is no discontinuity, merely a tailing-off in size as the wave gets farther from the line in which it entered. The physical explanation of all this is fairly simple if one recollects that what actually takes place at any given point during the passage of a wave is merely an up-and-down vibration, and that the wave is not material in itself and has no property of inertia independent of the local vibrations which constitute it. When, therefore, a wave comes through the entrance to the harbour the vibrations spread not only forwards but in all directions into the smooth waters, for each mass of water moving up and down communicates its motion to the adjacent water on all sides of it.

By a very simple experiment you can convince yourselves that a similar phenomenon takes place when light waves pass through an opening in an opaque material. Close one eye and look with the other through a narrow slit between your fingers at this candle flame. If the slit be fairly wide open you will see the candle as usual, but on pressing the fingers more closely together, and thus making a narrower slit, the flame appears to become broader and broader until it forms a horizontal band of light. Now the candle flame is itself unchanged; the apparent widening must, therefore, be due to an alteration in the direction of the rays entering the eye. The fact is that when a ray of light enters the eye from any given direction we see the source of it in that direction, whether it really is there or not. This widening therefore indicates that the light has spread out fanwise after passing through the slit, that in fact the waves are curving round into the shadows just as the sea waves do on entering a harbour. The same phenomenon is even more obvious with the longer electric waves such as are used in wireless telegraphy, though in this case it is usually complicated by actual conduction along the earth's surface.

Here I must point out that a conductor, in the common sense of the word, is not the only thing which will guide electrical waves; in fact, an insulator will conduct them along its surface if it has higher specific inductive capacity than the medium surrounding it. The truth appears to be that conduction is not primarily due to the fact that in a "conductor" electric current spreads by a process of diffusion in which there is energy dissipated as heat through resistance, but takes place along such a body because its dielectric rigidity is smaller than that of the air or other dielectric outside. If the body be a perfect insulator of finite specific inductive capacity, it will conduct alternate currents or waves only; but if its nature be such that it cannot permanently sustain electric stress it will also conduct a direct current, *i.e.* a wave of infinite length. It is this latter kind of material which is usually called a conductor; but, as you see, it has not an exclusive right to the name. As an illustration of this subject, I may say that in the conduction of electric waves in air along a water surface the large specific inductive capacity of water is actually of greater moment than the property which is usually called its conductivity. It will make this somewhat difficult subject clearer if I define conduction as the guidance of an electric disturbance by an interface between two media of different specific inductive capacity along a desired path which coincides with this interface. A simple instance will show the value of this definition. Suppose two parallel metal plates in air connected to the terminals of a source of alternating current. Now fit a straight rod of glass or other material of high specific inductive capacity from one plate to the other. The dielectric current, which was originally of practically equal density at all points between the plates, will now be much denser along the glass rod than elsewhere, and is in fact "conducted" by the glass rod. That this is so may be seen by twisting the rod into a curve or helix of which the ends are against the metal plates. The helix will still carry a large proportion of the total dielectric current between the plates in spite of its crookedness. It does in fact guide the electric current. You see, therefore, that conduction of electric waves at least is due to difference of electric rigidity, and that materials may conduct although they are perfect insulators.

In the transmission of electric waves through the atmosphere over sea and land, not only do conduction and reflection play their parts, but there is also refraction at work. Refraction is a change in the direction of a wave as it passes obliquely from one medium to another, or through a medium the density of which varies from

place to place. Suppose, for instance, that a medium decreases in density as one goes upwards and that the velocity of a wave of some kind is greater the rarer the medium; then if such a wave crest travels upwards in a sloping direction, the end of the crest which is highest will gradually gain on the other, slewing round so that the crest forms a curve which is concave in the forward direction. The upper part of the wave will now no longer be travelling in the direction in which it set out, but will be moving in a line more nearly horizontal. It will, in fact, have been refracted in its passage through the layers of decreasing density. The same is true when the wave is travelling in the reverse direction, except that of course in this case the front of the wave is convex in its direction of motion since the lower end is retarded.

In the passage of an electric wave over the earth from one wireless station to another all four phenomena occur. It is conducted by the ground or sea, it is diffracted round obstacles, refracted as it passes upwards or downwards through the atmosphere and reflected from the upper layers of the atmosphere. Of all these actions we have now direct evidence based on a large number of careful observations in different parts of the world. In 1906 I showed by deduction from the experiments of Duddell and Taylor that the conductivity of the earth or sea over which the waves passed controlled the amount of energy transmitted to the receiving station. Some years later I deduced the existence of an upper reflecting layer from observations made by observers at the Canadian stations on the Pacific coast. Both deductions have been amply confirmed by more recent observations, among which I must particularly mention those of Dr. C. J. de Groot, Chief Government Wireless Engineer in the Netherlands Indies. Dr. de Groot's results are extraordinarily interesting, and show, among other things, not only a single reflection from the upper atmosphere, but even a second one, signals from a small station having been heard at distances of 3,000 and 6,000 kilometres, though quite inaudible in the intervening spaces, except of course within a couple of hundred kilometres of the sending station. His observations also indicate a bending of the path of the waves as they travel upwards or downwards through the atmosphere, and go a long way towards explaining the curious variations in the strength of signals which occur daily in all latitudes, though more markedly in the tropics.

In the few moments that remain I shall show you a couple of experiments in the shorter waves known as light. The first proves that a coloured surface only shows up in its proper colour if illuminated by light which contains the wave-lengths proper to that colour. Here is a small lamp in which is burning spirits of wine mixed with common salt. It gives out a pure deep yellow light. Look at my face. You see it is now merely different shades of yellow, from a pale colour down to a dark yellowish grey. The red pigment therefore does not change the rate of the yellow vibrations, but simply fails to reflect them and the surface appears dark; it in fact absorbs all other colours but red, which it reflects.

In this other experiment I shall show you the difference between a light in which waves of all lengths are mingled, as sound waves are, in a comprehensive noise, and one in which there are a few definite waves as when one strikes a chord on the piano. On the screen you see three parallel bands of colour, the top and bottom ones showing a continuous gradation from deep red through all the colours of the rainbow to the faint heliotrope beyond the violet. These come from the upper and lower carbons of the arc lamp, and their continuity shows that the complexity of the vibrating particles in a white-hot solid is so great that all wave-lengths are given out. The middle band is the light from the arc itself, and instead of being continuous it is merely a ladder with rungs of brilliant colours, here a deep red line and there two green ones, and farther on there are others less well marked. This light comes from the free particles of hot gas between the carbons, and, as you might expect, their freedom is manifested by the radiation of definite and characteristic vibrations, no longer modified by the constraints of close aggregation as in a solid.

ONTARIO NICKEL MINES.

An interesting account is given, in "Canada the Country of the Twentieth Century," * of the nickel mines of the Sudbury district of Ontario, which are said to be the greatest in the world and to supply over two-thirds of the world's consumption of nickel. The town of Sudbury lies about thirty-five miles north of Georgian Bay. It may be reached from Montreal by a journey of about 440 miles westward on the main line of the Canadian Pacific Railway, or from Toronto by a journey of 260 miles northward on the Canadian Pacific or the Canadian Northern Railway. The nearest

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nickel mines are about two miles to the north and three miles to the west of the town. The smelting is for the most part carried on at Copper Cliff, a short distance from the town of Sudbury.

The nickel region has sharply defined geological boundaries, all the ore deposits being connected with a single great sheet of eruptive rock, roughly boat-shaped, having its interior filled with sedimentary rocks. The basin is thirty-six miles long, and sixteen miles wide, and the known ore deposits are all either along the edge of the sheet or less than four miles from it. The nickel deposits are not distributed uniformly around the basin. There are rich portions separated by barren intervals. Along a somewhat irregular line of thirty-three miles on the southern margin of the nickel-bearing eruptive rock, seventeen mines have produced ore, and within two or three miles to the south of it ten other mines have been worked. While some of the deposits appear to be pockets, there are a number of extensive bodies of ore. It is believed that the Canadian Copper Company has enough ore in two of its mines to last for sixty years, while there are a number of other mines supposed to contain great quantities of ore. The whole nickel basin includes an area of 550 square miles, divided among twenty-four townships. Mining has taken place in eight of these townships, and important ore deposits are known to exist in several others.

The Sudbury ores are sulphides, containing on an average about 40 per cent. of iron, 3·09 per cent. of nickel, 2·12 per cent. of copper, and small quantities of cobalt, gold, silver, platinum, and palladium. Bessemer nickel copper matte contains from 2½ to 7 oz. of silver, 0·02 to 0·3 oz. of gold, and 0·17 to 0·5 oz. of platinum and palladium per ton.

The iron content of the ore is thrown out and wasted in the smelting process, the aim being to produce a nickel-copper matte suitable for shipment to the refineries in the State of New Jersey and in Wales.

The Sudbury ores all contain large quantities of sulphur, and the first process to which they are subjected is roasting to remove part of the sulphur. They are then smelted in water-jacket furnaces, producing a matte which is resmelted in Bessemer converters, making a matte containing from 75 to 80 per cent. of nickel and copper, of which less than half is copper. In the roasting process the sulphur thrown off is entirely wasted. It destroys all vegetation in the neighbourhood.

In the year 1913 the mine-owners valued the nickel-copper matte as it was shipped abroad for refining at $7,076,945. After refining the nickel alone was valued at $14,903,032, and the copper at over $3,950,000, while the platinum and palladium were worth about $43,800—a total of nearly nineteen million dollars.

Large quantities of Canadian nickel have been used in making nickel steel for armour plate on warships. Nickel steel is also much used in the manufacture of motor-cars. It is coming into use for structural steel in bridge-building, as it has been found that steel containing from 2½ to 3½ per cent. of nickel has greater tensile strength and greater elasticity than the ordinary structural steel. Another alloy of nickel, known as monel metal, contains from 62 to 72 per cent. of nickel, with the balance copper, except for trifling quantities of iron, sulphur and carbon. It can be produced directly from the nickel-copper matte at a cost not greatly exceeding that of copper. It is silver white, takes a brilliant polish, which slowly turns greyish on exposure, melts at 1350° C., has the same specific gravity as copper, and can be cast or rolled and treated in various ways like copper or steel, but is distinctly stronger than ordinary steel or than manganese bronze.

BRITISH COLUMBIA TIMBER.

Some particulars of the principal woods of British Columbia, the Douglas fir, the red cedar, the hemlock, and the British Columbia spruce, given by Mr. H. R. Hamilton, Chief Forester of British Columbia, are quoted in "Canada the Country of the Twentieth Century."

The Douglas fir, of which there are many billion feet now standing, has remarkable strength and elasticity, as shown by the severest tests in competition with other woods, and yet it is 22 per cent. lighter in weight than the next best soft wood structural timber. Its use for general housebuilding, railway cars, packing houses, bridge and trestle work for railways, ships, barges, scows, docks, wooden pipes, and warehouses, where it is subject to moisture, rapid changes in temperature and great stress and strain, have proved its high resistance to decay. The ease with which it absorbs creosote and its natural hardness make it an ideal paving-block material. Sawn edge-grain, it makes a superlative floor, taking a high polish, never splintering, wearing long and evenly. Its strength, ease of working, and cheapness have made it popular in sash and door factories. Its beauty of grain, hard surface, ease of working, resistance to warping, shrinking or swelling, and its ability to take stains and paints, make it especially suitable for finishing.

The British Columbia red cedar reaches a maximum size of 200 ft. in height and 15 ft. in diameter, averaging from 100 to 150 ft. in height and 3 ft. in diameter. It is exceptionally light, weighing 23 lb. to the cubic foot kiln-dried. It is a soft wood of close, straight grain, takes stains and paints and holds them well, while changing conditions of weather, such as heavy rains or snows, with alternating dry, hot weather, do not cause it to warp, twist, or decay. These qualities make it eminently suitable for outside walls, porch roofs, columns or posts, or for construction of lattices, trellises, pergolas, arbours, and summer-houses. It makes a peerless roof, which is cool in summer, warm in winter, will not sweat, leak, or crack, and requires only light supporting framing. Most beautiful effects on both roofs and sides of buildings can

be obtained with fancy-stained shingles. British Columbia red cedar shingles are sawn edge-grain, and for this reason lie flat and will not warp or twist. By wetting shingles twenty-four hours before laying, and using zinc, copper, or galvanised nails, the life of the roof will be doubled. Its durability, suitable taper, great lengths, and its resistance to decay at the ground line, make it ideal for posts, telephone poles, and trolley poles. Its high resistance to weather action, and the long, wide, clear lumber obtainable, make it unequalled for row-boats, canoes, and motor-boats. The beautiful distinctive grain and smooth, high finish of British Columbia red cedar, and the fact that it takes and holds stains so admirably, while it never warps, splits, or twists, and can consequently be used in wide panels, make it an interior finish material second to none where it is not subjected to rough usage. Its odour, so pleasant to human beings, is obnoxious to moths and similar insects, and makes it a desirable lining for closets and store-rooms, and it will not soil or crack like plaster.

British Columbia hemlock is quite different from the eastern hemlock. It is of fine grain, soft, light, and strong. It reaches a maximum height of 200 ft., with a diameter of 5 ft., averaging 130 ft. in height and a diameter of 2 to 3 ft. It weighs 32 lb. per cubic foot, kiln-dried, and has only 12 per cent. less strength than the Douglas fir. It is specially suitable where ease of working, handsome finish, strength, lightness and tastelessness are desired, but needs paint or other preservatives when exposed to the weather. For framing and shelving it serves as well as Douglas fir. It makes an excellent flooring when cut edge-grain and used in dry places. It finishes smoothly on account of uniform texture, and wears evenly. Containing practically no pitch, having a beautiful grain, and taking stains readily, it can be used for inside finish, and when properly dried will not swell or shrink under normal conditions. It presents a comparatively hard surface, and consequently it makes good, cheap box material, but it is not adapted for direct contact with foodstuffs except where dry. It makes good laths, and is commonly used by western farmers for rat and mouse-proof building and receptacles. Exhaustive tests have shown that it is suited for all but the heaviest construction work, and it has been found satisfactory for piling on the British Columbia coast.

The British Columbia spruce is the largest of all the spruces, having a maximum height of 200 ft., with 10 ft. diameter, while it averages, when fully developed, 150 ft. in height, with a diameter of 4 to 5 ft. The weight is 26 lb. per cubic foot, kiln-dried. The wood is white in colour, odourless and tasteless, of rough fibre, does not warp, and is free from resin and pitch. It does not split easily in nailing even when worked to the least possible thickness for the manufacture of boxes, and its light weight gives it a low transportation cost. While not sufficiently strong for heavy structural work, it is well suited for many uses in general building. Its ease of working, light weight, and ability to take and hold nails, particularly adapt it for framing, sheathing, shelving, and sub-flooring. Its whiteness, tastelessness, and freedom from resin and pitch, make it particularly suitable for sink and laundry boards in houses and hotels, refrigerators, and the lining of refrigerator cars, and it is the most popular wood used in the construction of containers for the marketing of food products, such as butter and cheese, lard, meats, fish, berries, dried and canned fruits, and baking products. As a finish material it is soft and easily worked, takes and holds paints well, and has an attractive, cloudy appearance when stained. It is obtainable in large widths and lengths. Being tough, of light weight and sufficient strength, it is used for the manufacture of large doors for garages, freight warehouses, and dock buildings.

THE ROAD BOARD.

The sixth annual report of the Road Board shows that, in spite of the fact that its main source of income—the taxes on road traffic—has been diverted to the National Exchequer, the sum of £135,000 per annum is still left, and this is being laid out on the tar-treatment of the main roads of the country.

The Board is satisfied that "a surface dressing of tar is generally the most effective and cheapest method of preventing disintegration, and thereby prolonging the effective life of a road crust, provided that the surface is in sufficiently good condition to justify the application of the tar dressing."

After the war there will be a great amount of reconstruction work to be done on neglected roads. Just what kind of surface should be adopted in various situations may be settled, in many cases, as a result of the work done on the Road Board's road-testing machine at the National Physical Laboratory, which is described in the report.

The results of the more recent tests afford valuable information to which the attention of road authorities, engineers, and surveyors may be called. In addition to showing that bituminous surfaces, when carefully made and laid, are likely to be durable and economical, the tests appear to throw light on several of the causes of past failures.

The road-testing machine consists of a revolving frame supported on wheels running on a test path. The circular test path is 34 ft. diameter, and has a working width of 2 ft. The road material is laid down on a concrete foundation. On the surface to be tested the machine revolves at any desired speed, but when steel tyres are used, as has hitherto always been the case, this must not exceed seven miles an hour.

The road machine framework is supported by eight wheels, each 3 ft. 3 in. diameter by 3-in. tyre width. Each of these eight wheels is driven by its

own electric motor, so that the action on the test surfaces is nearly the same as that of a driving wheel of a motor lorry loaded to the same weight. In most cases the weight per inch of tyre width has been about 470 lb., but during the consolidation stage this has been sometimes increased to 750 lb.

The test surface may be kept either perfectly dry, or it may be sprayed to any desired degree of wetness, and as wetted surfaces can be tested to destruction sooner than when the track is kept dry, the wet test has now become the standard of comparison. During a wet test the whole of the material worn off by attrition can be collected and weighed, and thus the loss of material from actual wear can be accurately measured. The temperature of the test-room may be maintained at any desired point between that of the summer and winter seasons, and as bituminous materials soften and show the least resistance to deformation during the summer months, a temperature approaching that of summer has generally been maintained.

The tests are now carried out in the following manner: A manufacturer of road material or a road authority desiring to have his material tested sends about three tons of it ready mixed, in a motor waggon, so covered and protected from loss of heat that it can be delivered at a sufficiently high temperature, which is usually from 300° to 330° F., to be soft and plastic enough to be properly laid and finished. The hot material is filled into the track, then levelled by raking to the depth required to consolidate it to a finished carpet 1½ inches thick; the consolidation is then carried out by rolling it with the machine, or by hand rolling, or by tamping, as makers prefer.

At the time the track is laid, test samples are made in separate moulds and preserved for reference. The machine is then started and run on the new surface with a gradually increasing load, until about 4,000 to 6,000 tons per yard of width have rolled over it—this is called the consolidation period.

The test proper then commences—the machine is run at a load of 470 lb. per inch of width and at a rate of about 2,200 tons per yard of width per hour; the running hours are about eight per day, the track being kept wet all the time. The condition of the track is observed twice a day or oftener, and any defects which may appear are entered on the test sheets. The material worn off by attrition is collected as mud, dried and weighed. In most cases with good material a well-laid surface remains smooth and polished and but slightly marked until about 200,000 tons per yard of width have rolled over the track. Generally about this stage wave-like markings begin to appear. These gradually extend themselves until at 400,000 tons the surface becomes considerably waved, so that the vibration caused and communicated to the machine and building is excessive, and the test is then considered complete. Plaster casts are then taken to record the shape and the condition of the road surface—usually one of these is taken at the worst point where the surface is most waved, and another at the point where it is smoothest. Test pieces are cut out and their density compared with the first set of samples, so that the increase of density during the test can be recorded.

This appears to be a mode of testing which in some respects affords a more accurate means of comparison of certain qualities of road material than is possible when the material to be tested is laid in the open, exposed to the varying conditions of moisture and varying temperature of our climate and to irregularity of traffic, for these varying conditions render accurate comparisons difficult, so that the comparisons which can be made between the materials tested are necessarily uncertain and largely a matter of individual opinion.

RHODESIAN TRADE.

In the course of a paper on "The Development of Rhodesia from a Geographical Standpoint," which appears in the October number of the *Geographical Journal*, Mr. H. Wilson Fox makes some interesting remarks on the character of the European population of the country and the extent of its trade. "The settled areas in Southern Rhodesia," he says, "have a European population now exceeding 30,000 persons. In Northern Rhodesia the European population is only about 2,000, while settlement has been practically confined to three centres in the vicinity respectively of Livingstone, Lusaka, and Fort Jameson.

"Of this population I need only say on the present occasion that they are of the stuff of which empire-makers are made, and that they have always exhibited those virile qualities of courage and endurance without which the special difficulties of a new country cannot be overcome. The numbers of this population are at present small, some 32,000 in all, men, women, and children; but the results to which it has contributed are so striking as to require for their proper understanding a right appreciation of the part played by Europeans in what are primarily native territories, where the part of the European is, broadly speaking, to organise and supervise labour. Let me give you some figures. The total exports of Rhodesia during the ten years ended December 31st, 1914, represented a value of £25,928,481, and the corresponding value for imports is £30,484,384, showing a total trade during that period only of £56,412,865. The high-water figure was reached in the year preceding the war, when the exports from Rhodesia (North and South) amounted to about £4,500,000, and the imports to about £3,500,000, giving a total trade of approximately £8,000,000. A very important fact is that of this total trade at least £6,000,000 took place with Great Britain. Is it not very remarkable that the effect of establishing 32,000 persons in this new territory should have given rise in so short a time to a trade of such dimensions? You will perhaps think it even more remarkable when I tell you that the

annual value of the total trade of Great Britain with Germany before the war was about £130,000,000, or only about twenty times as large. Has not this fact a most important bearing on the real value to Great Britain of its territories overseas? On the one hand 30,000 of our own race give us a trade of about £200 annually per head of European population, while 70,000,000 Germans give us only £2 per head. Much of their trade, too, has been deliberately designed to injure us. Facts like these afford much food for reflection. They confirm the view which I have long held, that the chief value to Great Britain of its tropical and semi-tropical possessions is not that they supply an outlet for surplus population, but that they provide the trade which enables an increased number of our people to live at home."

THE OIL-SHALE FIELDS OF NORFOLK.

In a paper on "The Norfolk Oil-Shales," which was read before the Institution of Petroleum Technologists on October 17th, Mr. William Forbes-Leslie drew attention to the possibilities of a very important and comparatively little known oil-bearing district.

There is little doubt, he said, that a large oil-shale basin exists in Norfolk. The evidence for such belief rests upon an analysis of the structure of the east of England when brought into alignment with known tectonic conditions within the area. Its geographical extent has not yet been completely demonstrated, although its visible geological features have been traced for many miles north and south, and for considerable distances on the dip. The possibility of the Kimmeridge series being cut off against the edge of the chalk has not been lost sight of, but all research work in this direction goes to prove that the Kimmeridge beds dip underneath the chalk. No signs of faulting, such as cuts the Kimmeridge beds, and brings them against the chalk at Ridgeway, in Dorset, can be observed in the eastern section of the Wormegay basin. The boring at Holkham, 743 ft. deep, is said to have terminated in Kimmeridge clay, although another version makes it terminate in Lower Greensand. Nevertheless, adjacent and available data lead to a belief in the permanence of the Kimmeridge beds, beneath and seaward of the chalk shore line at Holkham and Hunstanton.

With a proved thickness of 6 ft. of oil-shale in Smith's series, and 6 ft. in the Puny Drain series, or a total of 12 ft., every acre of ground should yield something like 24,000 tons of shale, and half a square mile may be considered as providing for a 1,000 ton output per day for twenty years.

But with every indication that this estimate will be quadrupled or more, and with a possible extension of the basin very far beyond its present indefinite limits, it is obvious that the oil contents of the Norfolk end of the Kimmeridge outcrop will add very considerably to the oil resources of the United Kingdom.

Such a conclusion, which is borne out by careful examination of all authentic data, and by patient and laborious research in the field, implies that England is not so entirely destitute of oil resources as many people suppose. In the near future, the oil-fields of the Kimmeridge outcrop may be supplying a considerable bulk of the oil and petrol consumed in this country, and will enable the large amount of gold sent abroad every year to pay for foreign oil to be considerably reduced. This in itself is a matter of great importance from the view of national finance. The whole question of the English Kimmeridge measures demands investigation, for where one great productive basin exists in the south extremity of the Kimmeridge outcrop, and another great basin at the other, there is no adequate reason yet presented why there should not be other large productive basins in existence between these two geological terminals.

It is a national question. Private individuals have done much to demonstrate great deposits of oil in specific parts of these measures. The State, through the exigencies of war, is approaching that communal ideal when it may be called the mother of its citizens. Let it deal therefore with this most important economic question, the question of an internal supply of oil fuel, which more and more tends to underlie industrial efficiency, military and naval power, and might in the immediate future of the race comprehend even the basis of national existence.

RATTAN FURNITURE INDUSTRY IN HONG-KONG.

In reference to the note on this industry published in the *Journal* of August 11th, the following details regarding the processes used in preparing the canes for the industry may be of interest.

The sorting, cleaning, grading, and stripping of the canes is not done for the most part in Hong-Kong, but at villages in the neighbourhood of Canton, where labour is cheaper. The rattan must be thoroughly dried before treatment. After this is done the processes used may be summarised as follows:—

First the nodules, or bases of the leaf spathes, are pared off by women and girls, using knives fashioned like old files sharpened on one long edge. Next the rattan is sorted for sizes and grades. Those of certain diameters are taken out to be stripped for the cane and reed. Large pieces suitable for framework are specially imported in long bundles, undoubled. The rattan is then immersed in a vat containing water and sand. Some of the latter is picked up with a handful of wet coir (coconut husk), and this, when rubbed vigorously lengthwise over the surface, removes all foreign substances and brings out the real colour of the skin. Finally

if the rattan is stripped, unless it is intended to be used whole, the cane removed is bleached. If not stripped, it is bleached immediately after washing. This process is carried out in wooden boxes rather taller than a man and about 10 ft. wide, with two tiers of doors across the front. A quantity of sulphur is ignited in the bottom, and the rattan subjected to the fumes for about twenty-four hours. In stripping, the cane is removed by hand with a heavy clasp knife. It is gauged for thickness and width by drawing it between two vertical knives placed close together. The reed may then be split into as many strips as desired, the latter being rounded by drawing through holes in a sheet of iron. No machinery whatever is employed.

Five or six grades of the cane are recognised for most purposes. The first is of an even straw colour and thoroughly flexible; the second and third are less perfect in these respects, while the others lack an even colour and are little used for furniture, though suitable for binding purposes. The classification of the peel depends also on its flexibility and the evenness of its colour, and on the extent to which it has been cleaned. The care with which this grading is carried out marks an important difference between the handling of rattan in Hong-Kong and in the Philippines, and the indiscriminate sorting in bundles which is usual in the latter place forms undoubtedly an obstacle to the development of the industry there. Another obstacle in the Philippines appears to be the non-employment of suitable methods of washing and of any bleaching process, for without these no satisfactory classification based on the colour —and this is the most important of all—can be made.

The best demand is said to be for furniture covered with the reed, and next for the sea-grass product, while that for the types covered with cane is rather small. The principal export markets are the United States and South Africa, but a great deal of furniture is also sold in the China coast cities and in the various British possessions in Asia.

THE DRUGS AND SPICES OF SIAM.

Among the crude drugs produced in Siam is the well-known gum benzoin, a resinous exudation of a tree similar to *Styrax benzoin* of Sumatra. The Siam benzoin is gathered in the most northern forest regions of the country, and is highly esteemed for its delicate perfume, being used locally in the preparation of toilet waters and incenses, and in foreign countries chiefly for preparing compound balsamic tinctures. During the fiscal year ended March 31st, 1915, 52,251 lb. of crude benzoin, valued at £5,658, were available for export (against 17,824 lb., value £2,409, for the previous year), and the shipments were destined for the United Kingdom, Germany, Singapore, and Indo-China.

Gamboge is a yellow resin obtained from *Garcinia hanburii*, a tree which grows in the eastern Siamese Lau Provinces, and is used locally in the preparation of a golden-yellow ink, but abroad for medicinal purposes. Its export for 1914-15 amounted to 33,811 lb., valued at £2,353, as compared with 36,307 lb., value £2,664, for 1913-14, the United States, United Kingdom, Germany, France, Hong-Kong, and Singapore being the purchasers.

Cutch, the bark of *Acacia catechu*, or *Nauclea gambier*, is used medicinally and as a substitute for the areca nut in betel chewing, and also for tanning purposes. The export of cutch is confined to Oriental ports, and for last year amounted to 9,709 lb., valued at £46, against 21,729 lb., valued at £115, for 1913-14.

The cardamom classified as "best" in the Customs list and cultivated in the eastern provinces of Siam is the fruit of *Amomum xanthioides* and galanga, and is used by the natives in the preparation of curry, and is also employed for medicinal purposes. The amount available for export in 1914-15 was 4,595 lb., valued at £547, as compared with 32,577 lb., valued at £4,683, for 1913-14.

Another variety of cardamom, known as the "bastard," grows in eastern and northern Siam and is the fruit of *Amomum villosum*. This cardamom is used exclusively for medicine, and of this 33,886 lb., valued at £612, were shipped to Hong-Kong in 1914-15, against 235,200 lb., valued at £4,260, to that port and Singapore in the previous year.

Pepper is extensively grown in the province of Chantabun and in the Siamese Malay Peninsula and the amount available for export during 1914-15 was 3,283,780 lb., valued at £77,890, as compared with 2,568,813 lb., valued at £64,602, for the previous year. The bulk of the pepper exports go to the United Kingdom and the United States, the former taking 1,050,152 and the latter 770,670 lb. in 1914-15.

According to a report by the United States Vice-Consul at Bangkok, a number of other products of Siam's jungles and fields besides those mentioned above may also be had in quantities for export, namely, the wild cinnamon (*Cinnamomum silvestre*) of northern Siam; nutmeg (*Myristica fragrans*) from the province of Puket; cloves, ginger, tamarind, anise, liquorice, turmeric, til or sesame seed (*Sesamum indicum*), exported to Europe, and the oil extracted therefrom, said to be used for adulterating olive oil and for soap-making, but locally the oil is used medicinally; niger seeds (*Guizotia abyssinica*), which are used for the same purpose as sesame seeds; lotus seeds, which are mainly used for food during a scarcity of rice; arachis or groundnut, which is abundant in Siam, and the oil of which is used medicinally, for preparation of perfumes and cosmetics; pungtalal or jelly fruit (*Sterculia scaphigera*), which has a decidedly mucilaginous character, and is used locally in the preparation of cooling and medicinal drinks and for making jellies.

ARTS AND CRAFTS.

THE ARTS AND CRAFTS EXHIBITION AT BURLINGTON HOUSE (FIRST NOTICE).

An Arts and Craft Exhibition at Burlington House marks an epoch in the history of the Arts and Crafts movement. When the first exhibition was held in 1888, people did indeed talk of the possibility of craftwork being shown some day at the Academy, but the most hopeful of them only looked forward to its inclusion in the summer exhibition. A special exhibition, opened by the President of the Royal Academy, was beyond their wildest dreams. It says a great deal for the energy and enthusiasm of the members of the Arts and Crafts Exhibition Society, and still more for their foresight, that they have been willing to undertake so large an enterprise at the present time, when not only are many of the artists and craftsmen turned for the nonce into soldiers and sailors, but the difficulties of labour are almost insuperable. In spite of all this, Mr. Wilson and his committee have embarked upon an exhibition on a really grand scale. The walls of many of the rooms are decorated with paintings by well-known artists; the large room has been altered almost out of all knowledge; the sculpture room is turned into a group of small chapels adorned in various ways; and parts of several of the other galleries have been partitioned off, and decorated and furnished to represent bedrooms, a nursery, and the like—and all this without interfering unduly with the display of such objects as do not easily fit into such schemes of decoration.

The first room is devoted almost entirely to works by Morris, Crane (the two first presidents), Philip Webb, and Burne-Jones, and special rooms are set aside for jewellery and small metalwork, writing and book production, pottery, etc. The work was not completed by the opening day and the catalogue has not yet appeared, so that it is only possible at present to notice the exhibition in its main outlines; but enough is completed to show, what those who had seen the British Arts and Crafts section at Ghent suspected, that Mr. Wilson is a real genius in the conception and arrangement of exhibitions of this kind. There is only one respect in which the result seems somewhat disappointing. It has been said repeatedly that the justification for holding an exhibition of Arts and Crafts just now is the desire to show what English artists can do and to help British manufacturers to realise that, if they will but use the artists, they will in the future be able to meet with greater success foreign commercial competition. Still, in spite of the interesting little show arranged by the Art and Industries Association, consisting entirely of pottery produced under ordinary trade conditions, the present exhibition has, at first sight at any rate, very little bearing on this problem. One can imagine a manufacturer going round the galleries and remarking, "All this is very beautiful, but where do I come in?" On the other hand, there is evidently an abundance of excellent craftwork, and in the eyes of the ordinary visitor that will more than make up for any deficiency in exhibits more closely connected with industry and trade.

CORRESPONDENCE.

PINEAPPLE INDUSTRY IN THE AZORES.

I have read with interest the very excellent article in the *Journal of the Royal Society of Arts*, dated June 23rd, 1916, upon the question of pine-growing in the Azores. The writer is quite right in pointing out that these markets are now over-supplied with Azorean pines, but this is not only due to over-production but to the fact that the Continental markets—and chiefly Hamburg, which, according to the article, took 65 per cent. of the products—are now cut off.

The facts disclosed in the article in no way affect the question of production and sale of the South African pine. The latter, from a commercial point of view, is an entirely different article: it is about a third or half the size of the Azorean pine, its outward appearance is not so nice, but it is of better flavour, and on account of its small size and good colour it is better canning fruit; it can be produced for one-tenth of the price, and sold at 4*s*. per dozen landed here against 2*s*. 6*d*. each for Azorean pines.

For these reasons it appeals to a different section of the trade, and is a far more commercial article.

The following section of the article is of particular interest to me:—

> "When the production reached 50,000 cases annually, or 600,000 pineapples, fancy pineapple stock still brought 6*s*. to 8*s*. each in the London market. To-day, when the production is more than 2,300,000, the producers are obtaining only 6*d*. to 1*s*. 9*d*. each for their fruit."

Imagine 600,000 pines being sold at 6*s*. to 8*s*. each! I would like to get an order to supply 600,000 *dozen* of South African pines at less than that per dozen. The writer of the article complains that the producers are now obtaining only 6*d*. to 1*s*. 9*d*. each for their pines; well, the producers of South African pines will be very happy to get that price *per dozen* for their pines on their farms, and would produce millions of dozens at that price.

CHAS. P. CHIAPPINI,
Trades Commissioner.

Government of the Union of South Africa.
Trades Commissioner's Department,
90, Cannon Street, London, E.C.
October 11th, 1916.

GENERAL NOTES.

PAPER FROM HENEQUEN BY-PRODUCTS.—According to a report by the United States Commercial Agent at Vera Cruz, a machine has been invented for obtaining paper-pulp stock from henequen stalks and waste. The inventor, a Mr. George Taylor, states that he had been experimenting with henequen for two years for the purpose of obtaining a paper stock that would be equal in quality to that known to the trade as "kraft" stock, to be used in the manufacture of wrapping paper and paper bags. After he had obtained a pulp from henequen that met his requirements in every particular, he constructed a small experimental paper-making machine and produced a paper that was equal to, if not slightly better than, the paper manufactured from imported kraft stock, and that could be produced and marketed at a price considerably lower than that quoted for kraft paper. Several American manufacturers of paper bags and wrapping paper appointed one of their number to investigate the matter, and he accompanied Mr. Taylor to Yucatan to witness a practical demonstration of the new process in the field. This demonstration was held, and it was shown that the samples produced in the field were in every respect equal to the samples previously submitted by Mr. Taylor. As a result, a company has been organised to build and operate a pulp mill, which will have a capacity of 30 tons daily.

CHICLE INDUSTRY OF MEXICO.—Chicle is obtained by tapping the sapodilla (*Acras sapota*) trees, which grow wild in the forests of the State of Vera Cruz. The industry is controlled almost entirely by the Huasteca Indians, who sell the chicle in the markets of Tuxpam and Tampico. From two to four trees are generally found on an area of one acre of average virgin forest land in the Tuxpam district. In certain districts in the States of Campeche and Yucatan the average is much higher. The trees should be from twelve to fifteen years old before being tapped for the first time, and even then, unless great care is exercised by the tapper, they will die. It is said that the Indians, who use a machete, kill about 25 per cent. of the trees they tap. The trees in the Tuxpam district average from 1 lb. to 1¾ lb. of commercial chicle at each tapping; but they should be tapped only once a year, the best time being the winter months. According to a report by the United States Vice-Consul at Tampico, land containing sapodilla trees can be obtained in the vicinity of Tuxpam, but labour is expensive on account of the development of the oil industry. At present, however, owing to the depreciated currency, good Mexican labour can be secured for 1s. a day. During the year 1915, 347,815 lb. of chicle, valued at $57,728 (U.S.), equivalent to about £11,860, were shipped from Tampico to New York. Most of the chicle exported from Tampico is produced in the Tuxpam district.

COTTON IN UGANDA.—According to the annual report of the Department of Agriculture, Uganda, the cotton crop for 1914–15 was the highest on record, amounting to about 18,000,000 lb. The quantities exported were 107,139 cwt. of ginned cotton, valued at £320,486, and 30,188 cwt. of unginned cotton valued at £33,660, while the cotton seed exported amounted to 180,334 cwt., valued at £18,172. In consequence of the war, during a part of the period under review there was no market for the cotton, and the growers were unable to provide adequate storage accommodation. The result was disastrous, as many cotton plantations were neglected; in some cases the cotton was actually destroyed, as the planters despaired of being able to sell it. The area under cotton in the period 1914–15 was over 100,000 acres, of which more than three-quarters was in the Eastern Province.

PAPAYA PEPSIN IN THE PHILIPPINES.—It appears, from a report by the correspondent at Manila of the United States Department of Commerce, that an effort is being made to develop in the Philippine Islands an industry in the dried juice of the papaya (*Carica papaya*) for medicinal use as a substitute for pepsin. The preparation of this product is represented by the Bureau of Health officials, who are endeavouring to stimulate its production, as very simple. The fruit is hung above a bowl, and longitudinal cuts are made in the fruit from which the juice drips, hardening soon after it falls into the bowl. After being thoroughly dried in the sun it is put in sealed cartons for shipment. Papayas may be grown in almost every part of the islands. The native variety is small compared with the Hawaiian variety, which has been introduced and is now grown extensively for the table.

CLOTHING FOR THE BRITISH ARMY.—Some remarkable figures are quoted by the *Textile Mercury* showing the enormous quantities of goods ordered between August, 1914, and March 31st, 1916, for clothing the British army. Of woollen and worsted cloths the total was 117,000,000 yards, or sixty-one times the established peace average. Of flannel there were 84,000,000 yards, or enough in twelve months for forty-one years by old reckonings. Of cotton cloth of various kinds the total was 194,000,000 yards, or 175 times the average. 19,800,000 blankets had been placed on order, and 54,500,000 pairs of socks, 23,000,000 drawers, 8,750,000 vests, and 7,500,000 cardigans and jerseys.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

EXAMINATIONS.

The results of the 1916 Examinations have now been published in a pamphlet of 124 pages, folio, which can be obtained at the Society's offices, price 1*s*., or by post 1*s*. 3*d*.

Copies have been sent to all examination centres.

The results had previously been communicated to all the candidates.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

VIBRATIONS, WAVES AND RESONANCE.

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Lecture IV.—Delivered May 22nd, 1916.

In my earlier lectures I have given you many instances of the generation of waves by the vibration of a fixed oscillator; I come now to the converse process, namely, the conversion of the energy of a stream of waves into the vibration of an oscillator on which they impinge. It is here that the principle of resonance becomes of such immense value, for if it were not possible to absorb and store a small increment of energy from each wave as it comes along, adding them all up until the resultant vibration of the receiver becomes of appreciable magnitude, wireless telegraphy and telephony would be extremely limited in range and utility, and such achievements as the transmission of speech from Washington to Honolulu and the Eiffel Tower would not have been possible.

Here is a simple experiment which illustrates this action mechanically. This long lath, fixed vertically in a vice, and having an adjustable weight on it, is connected to a point on a long rope stretched across the room by an india-rubber band. I waggle the rope so as to cause a wave to travel forwards and backwards from end to end, and as each wave passes a small jerk is given to the rubber cord and thus to the lath. If the position of the weight on the lath is such that these impulses come just in time with its natural vibration it commences to vibrate, and as the impulses succeed one another the vibration becomes more and more energetic. If now I alter the height of the weight so that the rate of vibration no longer is the same as that of the incoming waves, the lath no longer gains in energy of motion but merely gives, from time to time, a few irregular movements of very small amplitude. The effect of tuning the receiver to the waves received is thus made manifest.

When we come to mechanical vibrations which are sufficiently rapid to be appreciated as sound, many striking demonstrations of resonance are possible. Have you ever thought why "intoning" is so commonly practised in large churches, and why the clergyman who strikes the right note can make his voice carry so much further than one who does not? It is simply a question of resonance. In one case advantage is taken of a natural rate of vibration of the mass of air in the part of the building where he stands; in the other there is no resonance, and instead of the radiation of sound waves from the whole mass of air from floor to roof there are only those which come direct from the mouth of the speaker. One can get the same effect very easily in any room of which the floor is bare, and in which there is but little furniture. Sing a slowly ascending scale, passing gradually from low to high without intervals, and you will find, if the room be bare enough, that at a certain pitch the sound swells out without effort on your part, and even the faintest note uttered of this pitch seems to fill the room and lasts long after you have ceased

to sing. Higher or lower notes are dead in tone by comparison and do not give the same satisfying sensation. On that note your voice was in tune with the natural vibration of the air in the room, and every vibration of your vocal chords added to the wave in the air just at the moment which helped it most.

Other experiments we have in plenty. Here, for instance, are two tuning-forks of the same pitch or rate of vibration. I sound one with the bow, and after holding it near the other for a short time I stop it vibrating. You can hear that the other has taken up the vibration and is now going. For those of you who are further off I have arranged this large glass bead on a thread which just rests against the side of the second fork. If I repeat the experiment, you see the bead begin to jump outwards from the fork and hear it clicking against it as it falls back and is thrown off again. I now put a small cap of lead on one of the prongs of the second fork, lowering its pitch a note or so as you see when I bow it. Again I try to make it resonate, but this time there is no sound and the bead no longer jumps. The forks now are out of tune.

The resonance of a column of air is well shown by holding a vibrating fork over this jar, which I gradually fill with water. As the water reaches a certain level the sound swells out and dies away again as more water is put in. There is thus a certain length of air column corresponding to each note, and the note is that which would be given out if the column of air were that of an organ pipe. These pear-shaped brass vessels in my hand have been made of such size and shape that the air in one of them resonates to this large fork, and that in the other to the small one. If I sound both forks while you put one of the resonators to your ear you notice that the sound of the corresponding fork appears to have become much louder. The amount of sound entering your ear has indeed become greater, for the resonator absorbs much more energy from the air waves than your unaided ear would do, for the simple reason that its natural rate of vibration is such that each wave arriving applies force in the direction in which the air is moving at the instant, and thus energy is absorbed in the most favourable circumstances.

There are, of course, air waves so slow that they are inaudible and others so fast that they also cannot be heard. At one time I lived near a deep railway cutting, so deep that but little was heard of the trains as they passed. Every now and then, however, the glass door of the verandah would commence to rattle slowly, a crescendo clack, clack, clack—about four clacks per second; then it died away. On listening outside one could hear that a train had just left the station and that the puff, puff, puff was now going faster than the door could vibrate. Each puff had been a long and almost inaudible wave, and as their rate increased it had for a short time coincided with the natural vibration of the door. Sir Hiram Maxim has written a pamphlet on the bat in which he discusses the use of the rose-like frills of skin which form so distinctive a feature of the faces of so many bats. These he suggests are organs for the detection of long air waves such as must be produced by the bat's own wings, and are therefore useful in enabling the animal to recognise the presence of trees and buildings through the waves reflected from them. The suggestion seems a reasonable one, and there is no doubt that the small vertical tongue which stands at the entrance to the bat's outer ear must have a frequency of vibration of the same order as the flapping of its wings, and should, therefore, be sensitive to the waves produced by them. Be this as it may, there is no doubt that there must be many inaudible "sounds" in the atmosphere which we could appreciate if only we had properly tuned receivers.

The use of tuned or monotone telephones, *i.e.* of telephone receivers which have very definite rates of vibration and therefore respond only to one note, has made it possible to send quite a large number of telegraphic messages simultaneously over the same line. At the transmitter a number of tuning-forks act as interrupters of the current, and each sends a steady stream of impulses over the line when its particular telegraphic key is pressed down. At the receiving end only that telephone sounds which is tuned to the fork used at the transmitter; and even if several messages are being sent at once on the different keys there is no confusion, for each receiver gets only the signals sent by the fork to which it is tuned. A system of this kind, invented by MM. Mercadier and Magunna, is in use in France and elsewhere, which, in addition to utility, forms a fine example of what can be done by resonance when there is perfect synchronism of the vibrator and resonator.

An interesting application of the same principle is in use by the Clyde Lighthouse Trust at Roseneath and Fort Matilda, near Greenock. The problem there was to start a light or an acetylene fog-gun by wireless control from a

station a few miles away. It was solved by controlling the transmitter by means of a pendulum so that it sends out an impulse at each beat of the pendulum, while at the receiver there is a similar pendulum which gets gradually into motion as each impulse, received by the wireless set and converted into a direct magnetic pull on the pendulum, adds its quotum of energy to those which have previously arrived. Finally, when the pendulum has got a large enough swing on, it makes an electrical contact and fires the gun.

Although the energy transmitted in the two cases just described is electrical the resonating arrangements are purely mechanical, and depend on the proper adjustment of the vibrations of masses of matter. In electrical resonance the result is obtained by proper choice of the electrical constants of the circuits concerned, and if—as is almost invariably the case—both circuits can oscillate freely, by the equalisation of their natural rates of vibration.

Here is an electrical oscillating circuit. I cannot energise it for fear of disturbing the Admiralty wireless station, but I can tell you how it acts. It is, as you see, very simple—merely a piece of wire with a plate on each end. To give it more inductance, *i.e.* to add to its inertia, it is usually coiled up into a helix or spiral, thus. This increases the magnetic energy of the current. To add to the capacity, and therefore increase the charge and energy for a given difference of potential, the flattened ends or plates are brought near to one another so that there is only a thin wall of dielectric between them. These processes also diminish the frequency and increase the length of the wave given out, the wave length being proportional to the square root of the product of capacity into inductance. If the plates are close together there is but little radiation from the circuit; for the purpose of radiating energy, therefore, as in wireless, instead of being comparatively small plates close together they are made very large, and are as far apart as is conveniently practicable, the upper one being the aerial wires and the lower the earth itself. We can thus obtain a circuit which, though tunable to a definite frequency, will also radiate a certain proportion of the energy of each oscillation in it.

Here I may note that although it is quite properly called a circuit, no electrical oscillator is a complete *metallic* circuit; it must have in it a section where energy is stored potentially, as well as one in which the storage is kinetic. The potential or static storage takes place in the dielectric between the plates and the kinetic in the medium surrounding the conductor during the passage of the current, and these, of course, take place alternately, first one and then the other. Its frequency of oscillation can thus be adjusted by variation of either inductance or capacity, or both.

This apparatus on the table is an electric circuit containing a small electric lamp, a condenser and a variable inductance in series; it is coupled electromagnetically to the alternating current supply from a central station. You see that by varying the inductance, and therefore the natural rate of oscillation of the circuit, I can find a point at which the lamp lights up brightly, although for neighbouring values of the inductance it is quite dark. The brightness, of course, indicates a large current through the lamp, and therefore shows that for this value of the capacity and inductance the circuit is in resonance with the alternating current of the supply.

In a wireless station the transmitter, as a rule, contains two circuits in resonance, the primary and the aerial, and often the low-frequency circuits are also tuned. The receiver has two tuned circuits at least, the aerial to the aerial of the transmitting station, and to one or more local circuits on the detector side. Resonance thus plays a very important part in wireless; its advantages are two in number: it enables one to work with a long train of waves of comparatively low voltage and still receive a considerable amount of energy, and at the same time ensures that waves which are not of the proper frequency do not actuate the receiver unless they are overpoweringly energetic. The simultaneous working of a number of stations in the same area is thus rendered possible and the range of transmission is increased.

Photo-chemical effects, including ordinary and colour photography and many other phenomena, are probably due to the resonance of molecules to light waves, a vibration being built up in the molecule which grows until the agitation is so great as to overcome attractions. The absorption of certain colours by certain pigments and coloured glasses and, in fact, all colouring in nature and in art, almost certainly depend directly or indirectly upon the same principle of resonance. If time permitted I would show you some of the beautiful demonstrations which are possible, but as it is I must content myself with showing you, before we part, a couple of experiments which summarise, in a simple way, some of the more important points in these lectures.

Stretched tightly across the room you see this cord, and hanging from it, near each end, a pair of vibrators, each just a spiral spring with a weight attached. I start this pair in motion and you notice that one bobs up and down more rapidly than the other; the weight is smaller or the spring stiffer. At the other end the vibrators have been carefully adjusted to have the same frequencies as these. Note the effect when I start one at this end, the slow one for instance. Almost immediately the slow one at the other end commences to move up and down and after a few swings is going strongly. The other keeps almost quite still. The vibration having ceased, I start the quick one, and immediately the corresponding one at the other end commences. Each answers only to the timed impulses sent along the cord by that which is "in tune" with it. Now I start both vibrators and both those at the other end respond. I alter the rates of vibration of either pair by adding or subtracting weights, and now, beyond a few feeble and erratic waggles, there is no response at all.

Here is the demonstration in a slightly different and even more interesting form. Over each end of this long watertrough two vibrators are suspended from firm supports. As before, they are in pairs, a rapid and a slow one at each end. The weights are partially submerged in the water, and if I move one up and down it sends out waves which you can see travelling along the trough. In a few moments you see the corresponding vibrator at the other end begin to move, and as before each is actuated only by the one of its own frequency. If both are started both respond, and if the frequency of either is altered there is no response.

Here, then, we have a vibration producing a series of waves, and, if there is a vibrator whose frequency is that of the incoming waves, an absorption of energy by resonance. We have also a proof that if the vibrator is not tuned to these waves the energy is not absorbed. Again, there is the proof that two sets of waves can co-exist in the same medium without mutual destruction, for when both vibrators at one end were started both those at the other answered to them and the only connection between them was the water, on whose surface both waves must therefore have existed simultaneously. In like manner we can see how two or more pairs of wireless stations can be worked independently and without interference in the same district; and how, as in Squier's "wired-wireless" system, a message in high-frequency currents can be signalled along a wire on which a telephone conversation is going on, without either set of waves interfering in the slightest degree with the other, indeed without the one message being even perceptible in the instrument used in receiving the other.

To the many and strange actions with which we have dealt, I must add the suggestion of another. When two particles, one positively and one negatively charged, revolve round one another they give out an electric wave whose period is that of their revolution. Thus there is reason to suppose that the waves of light, each a very small fraction of a millimetre in length, given out by a molecule of heated gas may originate in this way. Now the sun is probably positively charged while the earth is negative, and the one revolves round the other in a year; so, radiating from our system through interstellar space there are probably electric waves whose period is a year. Think of the length of them. They travel at three hundred thousand kilometres a second and each wave is a whole year long. Three hundred thousand times the seconds in a year is its length in kilometres. I leave the calculation to yourselves.

THE UNIVERSITIES OF LEEDS AND SHEFFIELD AND THE TECHNICAL PRESS.

Last May an invitation was given to the Circle of Scientific, Technical and Trade Journalists to visit the Imperial College of Science. A similar step was recently taken by the Universities of Leeds and Sheffield, which invited the Circle to form a party to visit these cities, as the guests of the Universities, on October 8th to 10th.

On arrival at Leeds the party, about twenty-five in number, were received by the Vice-Chancellor of Leeds University, Professor M. E. Sadler, and made welcome by representatives of the local press, and on the following day they proceeded to the University, where an inspiring address was delivered by Professor Sadler. The visitors were then conducted through the various departments of the University, and had an opportunity of seeing some of the valuable work carried out, much of it bearing directly on the local industries of Leeds. Since the outbreak of war many drugs previously only obtainable from abroad have been produced in the University, which is also acting in co-operation with National Dyes, Ltd. The section of the University devoted to textile work and dyes is stated to be unique in Western Europe, and the relations with local industries are close and cordial. As an instance of this recognition of the work of the University the visitors were shown the special research laboratory erected by

the leather industries as a tribute to the work of Professor Procter, the head of this department, on behalf of the leather trade. In this department, apart from the experiments constantly being conducted on processes involved in the manufacture and testing of leather, useful work on culture media for bacteria, on colloids and other subjects is constantly going on.

The visitors were subsequently entertained to lunch by the Leeds Luncheon Club, where an address on "India and the Empire" was delivered by Mr. H. A. L. Fisher (Vice-Chancellor of Sheffield University), and the Chairman said a few words in welcome to the party, for whom Mr. A. J. Mundella (Chairman of the London District of the Institute of Journalists) responded.

The afternoon was devoted to visits to several local factories concerned in the manufacture of boots and khaki garments for the Army—these industries being selected as being specially associated with the work of the University. Afterwards the party were entertained to tea by the Lord Mayor, leaving for Sheffield in the evening.

Here another excellent programme was arranged, the visitors being received and addressed by the Vice-Chancellor of the University, who explained that, although among the youngest of the leading educational institutions in this country, Sheffield University is already doing most useful scientific work. After passing through the chemical and medical departments an account of the work carried on in the department devoted to metallurgy was given by Dr. Ripper, the Dean of the Applied Science Section. Much of this work is closely associated with the war and is conducted by the University for various Government departments. It is interesting to notice that the University has been made the centre for meetings of the local Committee on Munitions. Over 1,000 students have been trained for munition work in the great Sheffield armament works. While the work of this department is chiefly associated with the production and testing of iron and steel, a non-ferrous department has recently been added, which has carried out useful researches on the production of cupro-nickel. In addition to this, many experiments have been conducted on problems arising in local metal industries since the outbreak of war. Two enterprising steps have also been recently taken by the University—the formation of a lectureship in Russian, and the organisation of a new department to investigate glass technology, the latter with the support of the Yorkshire Glass Association.

During the remainder of the day visits were paid to the works of Messrs. John Brown & Co., and of Messrs. Thos. Firth & Sons, where the operations are on a gigantic scale. Lunch was taken at the former works, where, in the unavoidable absence of the Master Cutler, an address was given by the general works manager and director, Mr. A. W. Dixon. Mr. Dixon emphasised the fact that Sheffield steel firms are fully alive to the benefits of applied science, and added that the provision of hygienic conditions for the workers received their constant care. Mr. Gilbert Wood and Mr. L. Gaster (Chairman of the Circle) replied for the visitors.

The visitors were deeply impressed by the evidence presented of a growing appreciation of the value of scientific methods in these two cities and the general recognition, on the part of manufacturers, of the good work the Universities are doing—a recognition that promises well for the industrial development of Leeds and Sheffield.

THE STRAW HATS AND BRAIDS OF TUSCANY.

The manufacture of straw hats and braids on a commercial scale is a comparatively modern industry in Florence, being slightly over one hundred years old. The growing of the fine thin straw that must be used is an industry peculiar to this part of Italy. Attempts have been made to grow it in other parts of the world, particularly Japan; but, although care was taken to get the proper seed and to plant it in soil similar to that in which the straw is grown in the Florence district, the results up to the present have been unsatisfactory.

From a report by the United States Consul at Florence it appears that the seed, which is obtained in the Apennine Mountains, between Bologna and Florence, is sown in the hill country which lies between Lastra-a-Segno and Empoli. The ground is prepared to a slight depth and the seed broadcasted by hand on the surface, where it is left uncovered to sprout. The thicker the seed is sown the more spindling the straw grows. The sowing is done in November and in May.

Just as the seed is coming into milk the entire plant, roots and all, is pulled from the ground. The stalks are laid out on the field to dry in the sun and turned from time to time. After this drying process is completed the crop is stacked or housed. During the autumn and winter the top joint, including the seed, is pulled out by hand, the remainder of the stalk, including the root, being kept by the farmer for his own use. The top joints are then gathered together and the seed part is carefully cut off. This is also put aside by the farmer and is used for reseeding or for feeding. That part of the top joint which remains is then cut into two sections, the upper, called "punta," being one-half or two-thirds the length of the lower, called "pedal."

The "punta" and "pedal" straws are then separately bunched and brought to the market, where they are purchased by manufacturers through "fattorini" (agents), or, in many cases, by the "fattorini" themselves. In order to get straws or

strands of a size they are sorted by a machine, the meshes of which are so arranged that by passing the bunched straws over the meshes those of the same size fall in the same bin. "Punta" and "pedal" straws are sorted separately. From the "punta" straws the fine so-called Leghorn hats are made; the "pedal" straws are made into what are known as Milan braids.

Leghorn braids are composed of nine, eleven, or thirteen strands, the braids being from one-eighth to nine-thirty-seconds of an inch in width, and 82 to 131 ft. in length. In general it may be said that the length is governed by the size of hat as determined by fashion experts. If the style calls for very large hats, it is sometimes necessary to splice two braids much in the same way as ropes are spliced. Milan braids are composed of five or seven strands, the braids being from one-fourth to one-half an inch wide, and of length to suit the size of hat wanted.

"Truciolo" straw is made into braids at Carpi, a town near Modena. These braids are employed for "chip" hats. The material used is not straw at all, although it is sometimes known as "rice straw." Great numbers of white poplar trees are grown in the River Po region in the Provinces of Reggio Emilia and Ferrara especially for the manufacture of this "straw." Four or five years after planting the trees are felled. All straight trunks and branches are cut into lengths of 20 to 24 in., the bark removed, and the piece squared and planed. The pieces are then passed through a special machine that cuts them into strands of any desired width and thickness. Three of these strands are used to plait a braid. The braids can be coloured or bleached to any desired shade.

Carpi has become renowned for "truciolo" braids, and besides utilising the home supply of poplar, its manufacturers import poplar and willow in 48-in. pieces from Bohemia and Russia. Although occasionally whole pieces are imported, it is more usual to import the strands. Bohemian "truciolo" straw is of a brighter colour, and has a more satiny finish; it is used for making women's hats. In the past, exportations of braids and hats were very heavy, but of late years, not only have fashions changed, but Japanese braids have cut heavily into the trade with the United States. Children's chip hats are still worn, and exports are confined almost entirely to goods adapted for such use. A three-strand braid is plaited from rushes or osiers, but this is seldom in demand.

Braids are also made of hemp imported from the Philippines. Although the Florence district produces great quantities of the fibre, the strands of Italian hemp are not considered strong enough to use in making hat braids. Hemp braids are also imported from Japan, and the hats are made in Florence. "Neapolitan" or horsehair hats are not made in the Florence district; these come from Canton Aargau, in Switzerland, and the hair used is either Swiss or Austrian. Depending upon the whim of fashion, braids are also made of twisted straw, of mixed straw and hemp, and of mixed straw and chip.

Generations of Tuscan women have braided straw, and seem to do the work mechanically. They are wonderfully deft, never looking at the strands, braiding while talking or walking or while carrying bundles upon their heads. Braid-making furnishes an occupation to thousands of women and girls and is a home industry, to be taken up or put down as circumstances require. The Italian peasant woman is never idle. The work is paid for by the piece, and earnings range from 4*d.* to 1*s.* 8*d.* per day, the latter amount being for the most expert workers.

In making Leghorn hats the braid is sewn edge to edge with straw of the same size. The braid used in making Milan hats is intended to be lapped. The projecting rough straw ends in the Leghorn plateaux are removed by rubbing two plateaux together. Before being made up the braids are bleached by means of a chemical wash.

The hats known as "Mountain," "Casentino," and "Marche" are all of the same kind; but these are made of straw after the thrashing has been done, only the first joint from the top being used. The braids are sewn together without lapping, just as Leghorns are made. They are really rough Leghorns except that the entire first joint of the straw is used as one piece, and is not cut into "punta" and "pedal" straws.

The United States offers the most extensive and best market. Many of the plateaux are blocked into hats in Florence, where this trade has passed down from father to son. While the plateaux are supposed to be of the same size when ready to be blocked, the sizes are, as a matter of fact, somewhat irregular. Florentine blockers are used to this and make the proper allowances; but in New York blockers find these slight irregularities a source of annoyance and trouble.

The value of straw hats and braids exported from Florence to the United States during 1910 was £241,000; in 1911, £230,000; in 1912, £254,000: in 1913, £178,000; and in 1914, £203,000.

The number of women and girls available for hat and braid work has been considerably reduced because of the higher pay that can be obtained in making clothes and uniforms for army contractors. As a consequence, hat and braid workers are scarce, and prices show a rising tendency. So, too, the cost of bleaching braids has risen 75 per cent., as chemicals can no longer be obtained from Germany.

THE VEGETABLE DYES OF INDIA.

Since the outbreak of the war in Europe investigations have been carried on in India jointly by the Departments of Industries in Mysore and Madras with a view to determining to what extent the present shortage of synthetic dyes could be made good by reverting to the natural dyestuffs of vegetable origin that were formerly employed.

The work has been carried out mainly in the laboratories of the Applied Chemistry Department of the Indian Institute of Science, and with Professor Sudborough have been associated Dr. H. E. Watson and Dr. F. Marsden, the tinctorial expert of the Government of Madras.

Dr. Marsden's report has recently been submitted to his Government, and is reproduced in the official *Indian Trade Journal*. The materials dealt with in the investigation included chay root, nunà, ventilago bark, *Rubia cordifolia*, red sanders wood, sappan wood, cutch, divi-divi and other tannin materials, annatto, kapila, lac and *Wrightia tinctoria* leaves. Concerning annatto, Dr. Marsden says :—

"The dye obtained from Jabara seeds was tested upon bleached mercerised cotton, upon which it gives a pleasing rich orange shade. The method of dyeing is simple, consisting in working the yarn in a warm alkaline bath made by extracting the dye from the dried seeds with water, and then adding a little carbonate of soda or potash. The dyeing is finished by giving a weak bath of acid and rinsing.

"It is generally assumed that the shades given by annatto are not fast; but I find that the fastness properties are equal to those of many of the bright aniline dyes which have been so largely used here, and there is no reason why, if the shade is liked, the material should not find a more extended use upon silk and cotton materials in which brightness of colour is a consideration."

THE WILD SAGE OF THE ADRIATIC.

Sage (Salvia) is an indigenous perennial shrub, growing in profusion on the mountains and hills in Croatia, Dalmatia, and the islands of Veglia and Cherso, in the Quarnero Gulf. The same species is said to grow naturally from Spain along the Mediterranean coast to and including the east side of the Adriatic. It is found mostly where there is a limestone formation with very little soil, but seems to grow in all kinds of places. Some of the barren hills in the region of Fiume have very little vegetation other than this wild sage. Its leaves are used in pharmacy, and its technical name is *Salvia officinalis*.

In appearance the wild sage is much like the common garden sage, although more shrubby in appearance. It generally grows to a height of 2 ft. and has narrow greenish-grey wrinkled leaves and purple flowers, variegated with shades of red and blue, that appear in whorls on stems, rather short and bushy in appearance, but tapering slightly towards the top. It has a more penetrating odour and is more bitter, spicy, and astringent than the cultivated plant.

This wild sage, says the United States Consul at Fiume, is the kind that is exported from the Adriatic region. It is chiefly gathered for that purpose in Dalmatia and on the islands, where the people do not have as many other sources of revenue and employment as in other districts of this region, where it grows naturally. Trieste is the centre of the export trade. A comparatively small amount is exported at any time from Fiume.

The best kind, it is stated, grows near Malinska, on the Island of Veglia, where the surrounding district is known as the sage region. There it is gathered before blooming, and by cutting the stem rather than pulling the plant up by the roots, as is the practice in some parts.

While wild sage seems very plentiful in the vicinity of Fiume, the business of gathering it commercially has not been taken up except on the near-by islands of Cherso and Veglia. During its blooming season the bees gather the nectar, and genuine sage honey commands the highest price, owing to its flavour.

In the region where this sage grows its leaves are boiled in vinegar and used as a tonic. A decoction is also made from it for darkening the hair. It is used more as a domestic remedy than by physicians. As a home remedy it has many reputed uses. It is given in the form of a tea for night-sweating and diarrhœa, and is used as a gargle for bleeding gums, catarrh, and to prevent an excessive flow of saliva. The oil is used for removing heavy collections of mucus in the respiratory organs. Its fresh leaves are used as a tooth wash, and it is a common ingredient in tooth powders. The dry leaves are used for smoking as a remedy for asthma. The domestic consumption accounts for a very small proportion of the crop, as it is gathered chiefly for export.

The leaves are harvested from May to September, but those plucked in midsummer are considered the best. The general opinion is that it should be gathered before the bloom opens, but the Austrian Pharmacopœia says it is best when gathered during bloom.

The only treatment given to the leaves intended for export is drying. They are separated from the sticks and stems, and are generally spread on shelves in the peasants' cottages and left until they are thoroughly dry, as any dampness proves injurious through heating and fermentation. Some of the more prosperous pickers have frames made with a galvanised-iron wire netting or screen bottom. The leaves are placed in these frames to a depth of about 3 in., and the frames are stacked one above the other and left until the drying is complete. Most of the pickers use shelves as first mentioned, being too poor to purchase the screen-bottomed frames. The leaves must not have sunlight while being dried, hence drying is done in the cottages of the pickers. There is no systematic gathering, as it is only done by people who do not have a more profitable use for their time.

When thoroughly dried the woolly, hairy dust of the leaves is removed by sifting. It is estimated that 9 lb. of fresh leaves produce 2 lb. of the dried herb. After drying, the leaves are sorted and generally pressed into bales of 100 to 300 kilog. (220 to 660 lb.) and bound with iron bands.

Three classes are recognised by the trade of Fiume: (*a*) large leaves that keep their shape and their green colour; (*b*) small leaves that curl and pulverise, losing their natural colour (if these are not dried in masses, but are spread out thin enough to prevent heating they become silvery); and (*c*) medium size and quality leaves prepared by the same process. The dry leaves should be kept in practically air-tight receptacles to preserve their strength. Those having a silvery-grey appearance are considered the best.

An essential oil is obtained by steam distillation of the fresh leaves, producing from 1·3 to 2·5 per cent. of oil.

The price of sage has advanced about 300 per cent. because of inability to get it. Large quantities were formerly sent to Germany, whence a good deal was shipped to Great Britain and the United States.

The wild sage of this region should not be confused with the other wild sages of Southern Europe and the Orient. *Salvia sclaria* (muscatelle sage) is a two-year growth in Southern Europe and in the Orient. It is often cultivated in gardens and appears wild in some places. Its plant and leaves are said to be added to wine to give it a muscatelle taste. Fermented with sugar and yeast it produces "clary wine."

Salvia pomifera is a shrub which grows in Greece and in Syria, with oval, notched, greyish, felt-like leaves, wave-like at the edges, and with flowers white spotted on the underside lip. As a result of stings of wasps, it produces round fleshy grey growths, about 5 centimetres in diameter, which are reputed to have a pleasant spicy taste. The stalks with leaves and flowers are used to make a tea, said to be popular in Greece.

COMPRESSIVE STRENGTH OF MORTARS AND CONCRETES.

A publication has been issued by the United States Bureau of Standards on the "Compressive Strength of Portland Cement, Mortars and Concretes" which will be of interest to contractors and engineers and, in fact, to all users of cement.

Concrete differs from most structural materials in that it is not manufactured at a mill or plant according to chemical formula, under the observation of skilled specialists, subject to rigid inspection and test, and such control as to produce a uniformly homogeneous product; nor is the process of manufacture completed in a few hours or days as in the case of steel products. Furthermore, concrete is made from materials obtained from sources differing widely in characteristics which affect its quality. The proportions of the ingredients, the amount of water used in mixing, the thoroughness of mixing, the manner of placing, the atmospheric temperature and humidity, exposure to sun, rain and wind, immersion in fresh water, sea water, or other natural solutions, all affect the quality of the concrete. All these matters are discussed in the Bureau's publication, which contains the results of some 20,000 tests. The general effect of variation in the methods of preparing the concrete is shown, and suggestions are given as to the proper methods to follow in order to obtain the best quality of concrete.

The paper states that certain generally accepted methods of testing aggregates and proportioning mixtures are incorrect, and suggests methods of selecting concrete aggregates, proportioning the mixture, mixing, placing, and curing. Copies of the publication, Technologic Paper No. 58, may be obtained free upon request to the Bureau of Standards, Washington, D.C.

MANUFACTURE OF BAR-LE-DUC JELLY.

Bar-le-Duc jellies and jams take their name from the town of Bar-le-Duc, capital of the Department of Meuse, which specialises in their manufacture. They are prepared with currants specially chosen on account of their size, but which are not produced by any particular variety of currant bush. The following outline of the method of preparation, contained in a report by the United States Consul in Paris, may be of interest:—

During the month of July each year trained workers receive from the factories quantities of currants, which they take home for the purpose of removing the seeds. In this process the berry is held in the fingers of one hand and the seeds are removed by means of a goose-quill sharpened to a fine point. The work is exceedingly difficult and requires considerable dexterity acquired by long practice. As soon as the currants are returned to the factory, sugar is added and the fruit cooked. The quantity of sugar used is much greater than in ordinary jams and jellies, owing to the fact that the jelly boils for only a short time in order to avoid the oversoftening of the berries. (Softening would cause them to lose their attractive appearance, which is the speciality of the Bar-le-Duc product, the whole berry being seen through the glass jar.) When prepared, the jelly is placed in small pots closed with a metal cap, and the pots are placed in boiling water to ensure the keeping qualities of the product. As Bar-le-Duc jelly is prepared chiefly for the export trade, this latter is essential.

Five firms at Bar-le-Duc manufacture jelly in normal times. It is doubtful whether the jelly is now being made, owing to the fact that the district is in close proximity to the firing line, and that many, if not most, of the civilians have left the region.

French statistics do not show the quantity of this jelly exported, but, upon examination of the total exports of jams prepared either with sugar or honey, it is found that the French export trade has decreased but little since the war, 1,005 tons of such jams having been exported in 1915, as compared with 1,025 tons in 1914 and 1,132 tons in 1913.

ENGINEERING NOTES.

Mechanical Milking.—The *Daily Telegraph* intimates that much saving would be effected by the extension of this process. On an up-to-date farm in Herefordshire a milking machine, in charge of one man, deals with seventy cows, which, were hand-milking in vogue, would require at least five expert milkers. The plant includes a vacuum pump driven by a 1½ h.p. motor, and connected by pipes to the milking machines that are placed in the cows' stalls. The machinery has a capacity for dealing with eighty-eight cows, the cost of operation being but a mere fraction of the wages of the men who would otherwise be employed. There need be no milk famine and no requests to the tribunals for the exemption of milkers, if only farmers would adopt the mechanical process. It is one that has everything to recommend it. Apart from reducing the cost of milk, the use of this plant tends to give cleaner milk since human hands and clothes do not come in contact with the animals, whilst if electricity is used for lighting the further possibility of contamination of the milk through the paraffin lanterns usually employed is avoided. A divisional traffic superintendent of the Great Western Railway has stated that the general adoption of mechanical milking would be the means of helping the railway companies out of a difficulty for which, up to the present time, no solution has been found. The question of acceleration of railway traffic in the early mornings really necessitates earlier milk trains—a proposal that has met with strong opposition from agricultural districts, as the farmers are unable to get the milk conveyed any earlier to the stations owing to the dislike of the farm hands to start milking operations before the usual hour. The general adoption of milking machinery, driven either by electricity or by an internal combustion engine, would enable milking to be carried out at the same time all the year round, no matter how many cows were kept, thus easing the railway companies' early morning traffic problem, besides giving many more men to the Army, and reducing the cost of one of the chief necessities of life.

Hydro-electric Power in Spain.—According to recently compiled statistics, the United States Consul-General Hurst at Barcelona reports the hydraulic power available in Spain is estimated at over 5,000,000 h.p. There are 110 large hydro-electric plants exploiting a total power of 281,490 h.p. and a large number of small plants; so that the whole amount of power in use may be reasonably estimated at 300,000 h.p. This total will probably be increased to 500,000 during 1916, when important installations are expected to be completed. The total potential horse-power controlled by the 110 large enterprises referred to is 1,020,790, and consequently 739,300 of their total power remains to be developed. Independent of this amount, numerous paper, spinning, and flour mills, and other manufacturing plants are run by water power not transformed into electricity. In Catalonia, North-Eastern Spain, the textile industries alone use some 200,000 h.p., about one-half of which is natural water power. The estimated power of the streams of the Pyrenees running through Catalonia amounts to 1,135,000 h.p., and the concessions have been granted for the exploitation of only 800,000 h.p. The water power of the rivers of Spain has been estimated as capable of producing horse-power as follows: Ebro and affluents, 1,300,000; Duero, 900,000; Guadalquiver, 750,000; Tajo, 700,000; Guadiano, 370,000; Mino, 250,000; Jucar, 190,000; Segura and affluents, 100,000; and others, 600,000; making a total of 5,160,000 h.p.

Influence of Hours of Work on Output of Munitions.—There is an interesting remark on this subject included in the report by the Committee of the Ministry of Munitions by Dr. H. M. Vernon referring to the health of workers. Experiments covering a considerable period fully justify the recommendation previously made by the Committee that the hours of work should not exceed sixty-five to sixty-seven hours for men and sixty hours for women; in many cases even a smaller number of hours per week would give the best results. Some striking examples of the effect of continued fatigue in diminishing output are recorded. Thus, in the case of some youths of fourteen to seventeen years, working on steel base plugs, a rise of 16 per cent. in hourly output took place after the Christmas holidays, and subsequently, when the hours of labour were reduced from 70·3 to 57·0, an increase of 42 per cent. was obtained. Thus, in spite of the diminution in the number of hours worked, an increase in total output of about 19 per cent. was reached. These and other results show that it is possible to be engaged for longer hours and yet do less work.

Docks for American Battleships.—The *Times* says that the new construction programme of the United States Navy Board, involving the expenditure of over £63,000,000 for new battleships and battle-cruisers, has, as might have been anticipated, brought with it the need for undertaking additional dry dock construction. It is well known that it was only the limitations imposed by wet and dry dock accommodation which, in days when merchant shipbuilding was pursuing a normal course, prevented the design and construction of yet larger ships than the huge liners which were put in service shortly before the war. The same considerations limit the increase in the size of battleships, which under the conditions of naval warfare must

have behind them at easily accessible points ample graving dock accommodation. In the case of the United States, the proposals which have been put forward for these facilities have been affected by the fact that the possibility of making the passage through the Panama Canal cannot under existing conditions be relied upon at all times. If for this reason, as some assert, the United States must provide both an Atlantic and a Pacific Fleet, it is equally certain that dry docks must be available on both seaboards. The scheme put forward includes the provision of several docks each of 1,000 ft. or more in length, one in the Hawaiian area, one in conjunction with a commercial enterprise on the Pacific coast near San Francisco, and a third at a point south of Hatteras on the Atlantic seaboard, while the fourth would be furnished by the enlargement of an existing dock. The decision to co-operate with commercial interests is significant, and it may be recalled that similar proposals, by which privately owned dry docks at British ports would have been enlarged to battleship dimensions in consideration of a financial undertaking by the Government, were not in past years favourably received by the Admiralty.

Fire Resistance of Reinforced Concrete.—A report has been issued by Mr. F. J. T. Stewart, the chairman of the Executive Committee of the National Fire Protection Association of the United States, on the fire which occurred at the Edison Phonograph Works, West Orange, New Jersey, in December, 1914. This is said to be the first time that a fire of great severity and wide area in buildings of reinforced concrete has been under careful technical observation. The ordinary brick, frame, and corrugated iron-clad frame buildings involved in the fire were mostly totally destroyed with their contents. But as regards the reinforced concrete buildings the panel walls withstood the fire excellently, and there was no case of individual collapse of a floor slab, beam, or girder, except in the basement of one building, where concrete and reinforcement were apparently melted away, causing failure of three beams and a floor slab. All other failures, including the complete collapse of a portion of one building, are attributable to the columns, the action of which was not so satisfactory as that of the other concrete members. All of them, except in one building, were square and reinforced by twisted bars placed at the four corners 2 in. to 4 in. below the surface. The conclusion is drawn that square reinforced concrete columns are not adapted to resist severe fire, and that these columns, together with variations in design or construction from present-day practice, must be held accountable for a large part of the structural injury produced. The complete absence of fire walls and other fire-resisting construction, coupled with inadequate fire-extinguishing apparatus, permitted large buildings to burn freely throughout, thus subjecting every portion of the concrete to long-continued severe heat, which produced excessive expansion stresses. The collapse of the columns is directly attributed to these expansion stresses, and it is pointed out that severe structural damage is liable to occur whenever buildings of this type of construction, with large unbroken areas filled with combustible material, are allowed to burn unhampered.

A Novel Gas Turbine.—In a recent issue of *Power* there was a description of the following combination introduced by the Detroit Gas Turbine Corporation. Its principle of operation consists in compressing a charge of the mixture, firing it at constant volume in an explosion chamber, which results in a very high pressure, and allowing the products of combustion to impinge on a series of moving and stationary blades. The arrangement shown consists of eight radial gas-compressor cylinders, which compress the gas mixture to about 90 lb. per square inch prior to its discharge into firing chambers round the periphery of the turbine, from which the products of combustion at high pressure impinge on two rows of moving blades separated by a row of stationary blades. The moving blades are carried on the outer casing, which revolves about the driving shaft on ball bearings, and is geared to the shaft through a three to one reduction, giving a shaft speed of 3,000 revolutions per minute, which corresponds to 24,000 explosions a minute. The rotor diameter for a 200 h.p. turbine is said to be 21 in. and the weight 335 lb.

The Motor Ship "Peru," with her two Sister Vessels.—In spite of the submarine menace, the motor ship "Peru," launched recently at Copenhagen by Messrs. Burmeister and Wain, has started on her maiden voyage to South Africa and Australia. These sister vessels—the "Peru," "Colombia" and "Chile"—have a length between perpendiculars of 425 ft., a beam of 55 ft., and a depth of 30 ft. 6 in., and a draught of 26 ft. 5 in. Their dead-weight capacity is 9,500 tons. Their propelling machinery consists of two six-cylinder Diesel engines, driving twin screws. The engines are designed to develop a total of 3,100 h.p. at 125 revolutions, and to give the ships a speed of 11·15 knots. The great difference which may characterise the performances of two sister ships, engines, or machines has often been remarked upon, and is well illustrated in the case of the "Peru" and the "Chile." On her trial trip the "Chile" engines, running at 136 revolutions, developed 3,318 indicated horse-power, and gave the ship a speed of 11·39 knots. The "Peru" on her trial trip developed 3,685 indicated horse-power at 139·3 revolutions, and showed a speed of 12·74 knots. The consumption of fuel oil on the

"Chile" was 147·6 grammes per indicated horse-power hour, and on the "Peru" 144·8 grammes. It is to be noted that the trial trip of the "Chile" was run during very cold weather, and that, as her bronze propellors were not ready in time for the trip, cast-iron screws were used in their place. Even so, the difference of 1¼ knots in the speed of the two vessels is remarkable.

Hong-Kong Harbour Works.—According to the report of the Governor of Hong-Kong for last year, the Mongkoktsui breakwater and contingent works were completed. The breakwater is 3,325 ft. in length, and encloses an area of 165 acres. Entrances to the refuge are provided at both ends of it, the southern one being 390 ft. in width and the northern 300 ft. The work also comprised a concrete and masonry pier, 450 ft. long by 30 ft. wide, and a reclamation extending over a rocky shoal near the northern entrance. The reclamation has an area of 187,000 sq. ft., and is protected partly by a pitched slope and partly by a concrete and masonry sea-wall. A short pier-head projects from the reclamation. The depth of water at the entrances at l.w.o.s.t. is 18 ft. The depth within the shelter varies from 9 ft. to 18 ft., 82 per cent. of the enclosed area having a depth exceeding 12 ft. at l.w.o.s.t. and 56 per cent. of depth exceeding 15 ft. The breakwater consists of a rubble mound 192 ft. wide at the base and 20 ft. at the top, with a height of 44 ft. Above low-water mark it is faced with concrete blocks on the outer side and coursed-granite pitching on the inner. The top is paved with concrete blocks. Before the rubble was deposited a trench with an average depth of 9 ft. was dredged in the harbour bottom for the whole length and width of the base of the breakwater. The rubble mound is composed of stones varying in weight from ½ cwt. to 5 tons, the total quantity deposited being about 850,000 tons. In all 12,453 concrete blocks, weighing two tons each, were used in the work, 11,379 being pitching and paving blocks, and the remainder principally foot-blocks for the inner slope. The foot-blocks for the heads of the breakwater are of granite encased in concrete, and are much heavier, weighing over five tons each. The foot-blocks for the outer slope are wholly of granite and weigh 3½ tons each. The granite pitching stones for the inner slope average half a ton in weight, 17,098 being used.

OBITUARY.

SIR JOSEPH BEECHAM, BT.—Sir Joseph Beecham, who was elected a Fellow of the Royal Society of Arts in 1913, died suddenly at his residence in Hampstead on October 23rd.

He was born in 1848, and in 1866 he joined his father, the late Thomas Beecham, the founder of the well-known firm of pill manufacturers. He claimed to be the greatest newspaper advertiser in the world, his yearly expenditure in this direction amounting to upwards of £100,000. Apart from his business interests, he was devoted to philanthropy and music. He and his son, Sir Thomas Beecham, were responsible for many operatic enterprises in London and the provinces, and for the season of Russian opera at Drury Lane, in recognition of which the Czar conferred on him the Order of St. Stanislaus. He was also the proprietor of the Aldwych Theatre, at which grand opera is being now produced. In 1914 he purchased the Covent Garden estate, which formerly belonged to the Duke of Bedford. He served for three years as mayor of St. Helen's, the town in which his works are situated. He was created a Knight in 1912, and a Baronet two years later.

NOTES ON BOOKS.

JOSEPH PENNELL'S PICTURES OF THE WONDER OF WORK. London: William Heinemann. 7*s.* 6*d.* net.

Some four years ago Mr. Pennell read a remarkable paper before the Royal Society of Arts, in which he gave forth his theory of art: "Work to-day is the greatest thing in the world, and the artist who best records it will be best remembered." From his youth he has devoted himself to the study of work—or should it be "works"?—and has found his favourite subjects in great chimney stacks, pillars of fire and clouds of smoke, huge cranes, skyscrapers, and monstrous dumps. The present volume contains a selection of fifty-two drawings—one of them made as long ago as 1880. A number of these were shown on the screen when Mr. Pennell read his paper here, and a few appeared in the *Journal* of December 20th, 1912. The collection deals with subjects in the United States, especially Philadelphia, Pittsburgh, and New York, and also in Europe, especially Italy, our own "Black Country," France, Belgium, and Germany. Mr. Pennell was in the last-named country when war broke out, and not the least interesting of the pictures in this book is the sketch of Krupp's works, Essen, where a great gun in process of manufacture is being swung on a crane across a workshop. It is perhaps to be regretted that none of Mr. Pennell's famous drawings of the Panama Canal are included in this collection, but the reason, no doubt, is that they have already been published in a separate volume.

Mr. Pennell's position as an artist is so secure and so well known that it would be superfluous to attempt to define it here. Probably no one can get a finer black-and-white effect than he from clouds of smoke and fire, or can render more artistically the bold lines of a cantilever bridge or a great factory. But

he has done well to publish this collection of drawings, as when they are studied all together they give one an increased sense of his power and versatility as a draughtsman; for although a similar thread runs through all the pictures, the subjects are enormously varied, ranging, as they do, from Pittsburgh Steel Works to the Carrara marble quarries and the rebuilding of the Campanile, Venice.

THE MIGRATIONS OF FISH. By Alexander Meek, M.Sc. London: Edward Arnold. 16s. net.

The importance of fish as a food has led of late years, and especially during the last two decades, to a wide and close study of their habits; and although the subject is so vast that up to the present a comparatively small portion of it has been covered, we do now know fairly definitely a certain amount concerning the biology of certain fishes, their habits, their reproductive powers, their spawning grounds, and their rates of growth. Much of the information which has hitherto been collected, however, is scattered about in various papers and periodicals, and the time is ripe for setting down in systematic form what is known of fish migrations at the present time. This is the task which Professor Meek has set himself in the volume before us.

The author has dealt with nearly all the various families of fish, but naturally—both on account of their greater practical importance to us and the fact that they have been more closely studied—the food fishes of the Northern Hemisphere have been most fully treated. Especially full and interesting are the chapters which describe the migrations of herring, salmon and trout, conger and other eels, cod, and the flat fishes. As Director of the Dove Marine Laboratory at Cullercoats, Professor Meek has had special facilities for studying the movements of herring, which annually visit the east coast of this country in enormous shoals, and it would appear that our knowledge of the migrations of these very valuable food fishes is now becoming fairly complete.

A word of praise must be given to the illustrations, which are numerous and excellently reproduced, while the maps, showing the distribution of the various fish families are of remarkable interest. In fact, the whole work is a scientific and masterly exposition of a most important branch of biological study.

GENERAL NOTES.

A PAPER FIBRE.—Tambookie, or tambootie, grass, which grows luxuriantly over vast tracts of land in the Transvaal, is said to have a promising future in connection with the manufacture of paper. The *Bulletin* of the Imperial Institute says that this grass has been proved to yield, under the same conditions, more pulp than Algerian esparto grass, but a little less than Spanish esparto. Not only is the yield high, but the pulp is of good quality, and can be easily bleached. Paper-making trials at the Imperial Institute show that a satisfactory paper of fairly good strength can be made from tambookie grass pulp. The most remunerative use for the grass will probably be to convert it in South Africa into "half-stuff," which can be exported to Europe or used for paper-making locally. Specimens of the grass and of paper made from it may be seen in the South African Court of the Imperial Institute.

TRADE IN NORTHERN MANCHURIA.—The *London and China Telegraph* quotes some interesting points concerning the commercial situation in Northern Manchuria during 1915 from a recent report by the United States Consul at Harbin. Hitherto all trade has been on a long-credit basis—a system established by the Germans. Now credits are everywhere refused. It was supposed trade could not readily revive because not enough cash could be found to finance it on a cash basis. But to the surprise of commercial circles the Chinese found money readily enough, and for the first time in its history trade in Northern Manchuria during 1915 was conducted on a strictly cash basis. One of the most interesting developments of the year was the success of the Japanese in making Harbin a distributing centre for both import and export trade with Russia. They were quick to see the natural advantages of its geographical and trade-route position, and to grasp the opportunities that proximity, cheap labour, and direct railway and shipping connections gave them. By far the largest foreign product imported in Northern Manchuria for domestic use is cotton piece goods. A few years ago American piece goods occupied easily the first place in the Manchurian trade, with British and Japanese goods fighting for the second place. To-day Japanese piece goods have practically driven every competitor from the market. Japanese business houses are now endeavouring to achieve the same result with articles of clothing, canned foods, manufactures of hardware and leather—in fact, with a remarkable variety of articles.

CHINESE BEAN "MILK."—Bean "milk" has long been known to the Chinese under the name of to fu chiang, or bean-curd sauce. It is made from the small yellow beans from which the Chinese bean curd and chiang yu or soy are made. The beans are soaked and then crushed between two stones. The crushed mass is allowed to run off into a tub, and is then strained through cheesecloth and diluted with water and boiled. After boiling it is again strained, and the white milk run off into bottles. An analysis of the bean-curd milk shows that it has a specific gravity of 1·020 and a fat content of 3·125. To the eye, according to the United States Consul at Changsha, the product looks exactly like unskimmed cows' milk. It has an odour of raw beans, and is said to be not unpleasant to the taste.

Swiney Lectures on Geology.—A course of twelve lectures on "The Mineral Resources of Europe" will be delivered by Mr. John S. Flett, F.R.S., at the Royal Society of Arts, on Tuesdays, Thursdays, and Fridays, at 5 p.m., beginning Tuesday, November 14th, and ending Friday, December 8th. The lectures will deal with coal, petroleum, iron, copper, tin, manganese, lead, the precious metals, and salt.

School of Art Wood-carving.—The School of Art Wood-carving, South Kensington, has been reopened after the usual summer vacation. Some of the free studentships maintained by means of funds granted to the school by the London County Council are vacant. The day classes of the school are held from 9 a.m. to 1 p.m. and 2 to 5 p.m. on five days a week, and from 9 a.m. to 1 p.m. on Saturdays. The evening class meets on Monday and Friday evenings from 7.30 to 9.30 p.m. Forms of application for the free studentships and any further particulars relating to the school may be obtained from the Registrar.

Deaths from Wild Animals in Bengal.—There was an increase in the total number of persons killed by wild animals in Bengal during the last year, the figure being 423 against 332 in the preceding year. This increase is shared by all divisions, except Chittagong. Deaths from snake-bite rose from 4,356 to 4,709. This large increase is due to excessive floods which drove snakes to take shelter in human habitations. Some 4,185 head of cattle were killed by wild animals and 188 by snakes. A total of 2,769 wild animals were destroyed, of which 275 were tigers and 496 leopards; 11,893 snakes were destroyed last year. The amount paid in reward for destruction of wild animals was Rs. 17,977.

Philippine Shrub Perfume.—According to a report by the correspondent at Manila of the United States Department of Commerce, the perfume known in trade circles as "cassie," manufactured for the most part in France, is found in abundance in the Philippine Islands in the *Acacia farnesiana*, a shrub which grows near Manila and throughout the dry parts of the islands. This shrub has small spiny leaves and produces a short black pod. The flower from which the essence is obtained is very abundant and of a golden colour It is known locally as "aroma."

Fuel Economy.—Owing to the high price of coal in the south of France, old newspapers and other waste paper are being used for making fire-balls for burning with coal or anthracite in close stoves for heating purposes. The paper is soaked in water for twenty-four or forty-eight hours, and then kneaded and pressed into shape to about the size of a golf or tennis ball, and then dried in the sun. When the fire is well alight the balls can be used in the proportion of one-quarter to one-third of the coal.

MEETINGS FOR THE ENSUING WEEK.

Monday, October 30...Farmers' Club, at the Surveyors' Institution, 12, Great George-street, S.W., 4 p.m. Professor T. H. Middleton, "The Farmer's Task."

Tuesday, October 31...Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. S. Routledge, "Incidents in an Exploratory Voyage of 100,000 miles in the yacht 'Mana,' and the Great Images of Easter Island."

Anthropological Institute, 50, Great Russell-street, W.C., 5 p.m. Mr. A. Trevor-Battye, "The Gurkhas and their Country."

Röntgen Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8.15 p.m. Presidential Address.

Wednesday, November 1...Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. T. E. Wallis, "Quantitative Microscopy." 2. Mr. C. C. Roberts, "Formula for converting Zeiss Butyro-Refractometer readings into Refractive Indices." 3. Messrs. C. Revis and H. R. Burnett, "Criticism of Vaubel's Bromine Values."

Thursday, November 2...Linnean Society, Burlington House, W., 8 p.m.

Chemical Society, Burlington House, W., 8 p.m. 1. Mr. E. Newbery, "Overvoltage tables. Part IV. —The theories of overvoltage and passivity." 2. Messrs. C. A. Seyler and P. V. Lloyd, "Studies of the carbonates. Part II.—Hydrolysis of sodium carbonate and bicarbonate, and the ionisation constants of carbonic acid." 3. Mr. M. Nierenstein, "The synthesis of hydroxyquercetin." 4. (*a*) Mr. E. G. J. Hartley, "The reaction between methyl iodide and some metallic cyanides"; (*b*) "Some reactions produced by mercuric iodide." 5. Messrs. H. M. Dawson and T. W. Crann, "The dual theory of acid catalysis. A comparison of the activities of certain strong acids."

Friday, November 3...Chadwick Public Lecture, at the Royal Society of Arts, John-street, Adelphi, W.C., 5.15 p.m. Dr. W. Stirling, "Fatigue, and its effects on Industry and Efficiency." (Lecture II.)

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. (Thomas Hawksley Lecture.) Mr. H. Jones, "The Gas Engineer of the last Century."

THE LIBRARY.

The following books have been presented to the Library since the last announcement. Except where otherwise stated they have been presented by the publishers:—

Ballhatchet, Albert V.—Electrical Apparatus-Making for Beginners. London: Percival Marshall & Co., 1916.

Barnes, Alfred A.—Hydraulic Flow Reviewed. London: E. & F. N. Spon, Ltd., 1916.

Batliboi, Jamshed R.—Advanced Accounts. Bombay, 1916. Presented by the Author.

Batsford, Herbert.—English Mural Monuments and Tombstones. London: B. T. Batsford, Ltd.

Beaumont, Professor Roberts, M.Sc.—Standard Cloths. London: Scott, Greenwood & Son, 1916.

Bell, Edward, M.A., F.S.A.—The Architecture of Ancient Egypt. London: G. Bell & Sons, Ltd., 1915.

Benn, Ernest J. P.—Trade as a Science. London: Jarrold & Sons.

Brown, Thomas, and Vincent E. Collinge.—Arithmetic and Book-keeping. Part I. Sir Isaac Pitman & Sons, Ltd., 1916.

Buxton, Charles Roden.—Towards a Lasting Settlement. London: George Allen & Unwin, Ltd., 1915.

Cross, C. F., and E. J. Bevan.—A Text-Book of Paper-Making. Fourth Edition. London: E. & F. N. Spon, Ltd., 1916.

Cucchi, C. P.—New Italian Grammar. London, 1912. Presented by the Author.

Cundall, Frank, F.S.A.—Historic Jamaica. London: West India Committee, 1915. Presented by the Author.

Dhari, Alakh.—(1) The Growth of Currency Organisations in India. Bombay Chronicle Press, 1915; (2) Co-operative Credit in Gwalior State. Lucknow: Newul Kishore Press, 1915. Presented by the Author.

Dunk, John L.—Hyperacoustics: Division I. Simultaneous Tonality. London: J. M. Dent & Sons, Ltd., 1916. Presented by the Author.

Enock, C. R.—(1) The Tropics; (2) Can we Set the World in Order? London: Grant Richards, Ltd., 1915 and 1916.

Higgins, S. H., M.Sc.—Dyeing in Germany and America. Second Edition. Manchester: University Press, 1916.

Hoffman, Frederick L., LL.D.—The Mortality from Cancer throughout the World. Newark, New Jersey: The Prudential Press, 1915.

Ibbotson, Fred, B.Sc., and Leslie Aitchison.—The Analysis of Non-Ferrous Alloys. London: Longmans, Green & Co., 1915.

Jennings, Arthur Seymour.—Paint and Colour Mixing. Fifth Edition. London: E. & F. N. Spon, Ltd., 1915.

Johnstone, Sydney J., B.Sc.—The Rare Earth Industry. London: Crosby Lockwood & Son, 1915.

Kingsbury, J. E.—The Telephone and Telephone Exchanges. London: Longmans, Green & Co., 1915.

Magnus, Leonard A., LL.B.—The Tale of the Armament of Igor, A.D. 1185. Translated from the Russian. Oxford University Press, 1915.

Meek, Alexander, M.Sc.—The Migrations of Fish. London: Edwin Arnold, 1916.

Oil Seeds and Feeding Cakes. Imperial Institute Monograph. London: John Murray, 1915.

Palmer, A. Risdon, B.Sc., B.A., and James Stephenson, M.A., M.Com., B.Sc.—Commercial Arithmetic and Accounts. Two Parts. London: G. Bell & Sons, Ltd., 1916.

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London: Printed by WILLIAM CLOWES & SONS, LTD., Duke Street, Stamford Street, S.E., and published for the Royal Society of Arts by G. BELL & SONS, LTD., York House, Portugal Street, W.C., in the Parish of St. Clement Danes, in the City of Westminster.—October 27, 1916.

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FRIDAY, NOVEMBER 3, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

ARRANGEMENTS FOR THE SESSION.

The Opening Meeting of the One Hundred and Sixty-Third Session will be held at 4.30 p.m. on Wednesday, November 15th, when an address will be delivered by DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, on "The Stability of Great Britain."

The following arrangements have been made for the meetings before Christmas:—

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

NOVEMBER 22.—LESLIE URQUHART, "The Economic Development of Russia and Britain's Share therein." The RIGHT HON. LORD CARNOCK, G.C.B., G.C.M.G., G.C.V.O., K.C.I.E., British Ambassador in Russia, 1906-1910, will preside.

NOVEMBER 29.—

DECEMBER 6.—C. M. WHITTAKER, B.Sc., "The Coal-Tar Colour Industry."

DECEMBER 13.—H. WILSON FOX, "The Development of Imperial Resources."

DECEMBER 20 (at 4 p.m.).—A. C. BENSON, C.V.O., Master of Magdalene College, Cambridge, "Classical and Scientific Education."

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

DECEMBER 14.—JOHN ALTON TODD, B.L., Professor of Economics, University College, Nottingham, "The World's Cotton Supply and India's Share in it."

HOWARD LECTURES.

Monday afternoons, at 5 p.m.:—

JOHN S. S. BRAME, Professor of Chemistry, Royal Naval College, Greenwich, "Coal and its Economic Utilization." Three Lectures. November 27, December 4, 11.

JUVENILE LECTURES.

Wednesday afternoons, January 3 and 10, at 3 p.m.:—

ALAN A. CAMPBELL SWINTON, F.R.S., "Electricity and its Applications." Two Lectures.

A further announcement will be issued in the next number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

EXAMINATIONS, 1916.

The Society's examinations have now been conducted on their present system for just sixty years. They were established in 1856, it was in 1857 that the first provincial examination was held, and in 1858 the system was established under which local committees were appointed to supervise examinations worked from a single centre.

At that time there was a craze for examinations. In 1854 "selection by examination as a method of appointment to posts in the English public service was first substituted for the patronage system."* The first competitive examination for the Royal Military Academy was held in 1855, though it was not till 1870 that the principle of open competition for the Civil Service was generally adopted. The Oxford and Cambridge Local Examinations were established in 1858, and the Science Examinations of the Science and Art Department in 1861.

The scope of the Society's examinations at first was very wide, and included practically all the subjects of general education, but the field was restricted as other agencies took up various parts of the work. The establishment of the University Local Examinations induced the Society to abandon its purely literary subjects, while the examinations of the Science and Art Department led to the giving up of the scientific papers. The result was that only the commercial subjects were retained, with the addition of—for some years—Domestic Economy and —down to the present date—Music.

On two occasions, in 1871 and in 1879, it was proposed to discontinue the examinations, and on both the idea was abandoned in consequence of pressure put upon the Council by local institutions.

From time to time subjects have been dropped out as they came to be dealt with by other agencies, and new subjects were

* From the excellent article on "Examinations" in the eleventh edition of the "Encyclopædia Britannica," by P. J. Hartog and Arthur Watson. This article, complete as it is in most respects, seems entirely to ignore the Science and Art Department's Examinations, continued from 1861 to 1911.

introduced to meet the demands of commercial education.

Changes have also been made in the general classification or arrangement of the grades of examination. At first the examinations were only of one grade with three classes. In 1897 an Elementary grade was added of a single class only. This arrangement went on till 1905, when it was recast, and the present system introduced with its three stages—Advanced, Intermediate, and Elementary—the two upper stages being divided into two classes, first and second, and the Elementary consisting of a single class only. On the whole, therefore, it will be seen that the original system still remains, with no organic change and with only reasonable development and growth, so that it may certainly be said to have stood the test of time remarkably well.

Up to 1880 the examinations were free, and the Society expended a large amount of money on their development. When in 1882 the idea of abandoning the examinations was given up, it was determined to try whether they could not be made self-supporting. It was believed that a fee of 2*s.* 6*d.* for each candidate would be sufficient at all events to prevent any serious loss. In practice this anticipation proved accurate, and from that date to this year, this fee has been charged.* When it was first determined upon it was only intended to minimise the loss, and the Society was quite prepared to expend a certain amount annually on the examinations. But their enormous development from 1883 to 1914 has enabled them, since the number of entries became large, to be carried on without loss, and in some years even to bring in a small margin of profit. Of course many departments of the examinations have always been unprofitable. But the profit on those subjects for which very large numbers enter was just sufficient to make up for the loss on the non-paying subjects, and so long as the Society was not called upon to provide amounts which would be a serious tax upon its moderate resources, the Council was perfectly content to carry on a useful public work, without much consideration as to whether the actual result was a small profit or a small loss.

Previous to 1880, when the examinations were free, the largest number of candidates in any year was a little over 2,000. This number was reached and surpassed in 1890. During the next ten years there was a steady annual increase, till in 1900 there were nearly 9,000. The effect of the Technical Instruction Act of 1889 sent the numbers up in 1901 to over 12,000. In the following year there was a trifling increase. In 1903 they passed 16,000, in 1904 they nearly reached 18,000; and in 1905 they exceeded 21,000. In the next three years there was a moderate increase up to 22,000; and in 1909 they shot up to more than 25,000. In two years more they passed 27,000; and in 1914, after a decrease for two years, they reached their highest point, 29,000. This growth of the examinations since 1900 is shown in diagrammatic form on page 847.

As was naturally to be expected, the carrying out of the Society's examinations this year has been a work of considerable difficulty. The staff, never quite large enough to compete satisfactorily with the increase of the work, has had to supply its quota to the Army, but, fortunately enough, the clerks engaged on the examinations were not called up until all the preparations for both divisions of the examination were completed, and so the only real harm done was that there has been a not very serious delay in the publication of the results and the issue of the certificates. Not only was there a deficiency in the working staff, but several of the examiners were occupied with war work, and others had lost the help of clerks and assistants on whom they had previously depended.

The local educational authorities also had their own difficulties, caused by lighting regulations, diminution of railway facilities, and other like matters. These were met by authorising the holding of the examinations at earlier hours when necessary, due precautions being taken to preserve the secrecy of the papers of questions.

On the whole, it is satisfactory to be able to report that none of the anticipated difficulties were found insurmountable; so that, as above mentioned, the only matter demanding an apology is that the printed results were not published at quite so early a date as usual.

As regards the number examined it is disappointing, but not unexpected, to have to report a diminution again this year. This is to be attributed certainly and solely to the war, and perhaps it ought to be considered a matter for congratulation that the numbers have kept up as well as they have.

It was confidently anticipated in 1914 that in consequence of the new arrangements under which a double examination was held, instead of all the examinations being held at one period of the year, the rate of increase would have been still more rapid, and that the numbers for 1915 would have been larger than ever. These calculations, however, were upset by the war, and

* A lower fee is charged for the Elementary Stage.

there was, instead of the expected growth, a considerable diminution in numbers. It was certain that a further loss would be felt this year, but there was some hope that the falling-off might have been comparatively small, and this was encouraged by the fact that, compared with last year, the entries for the first division of the examinations, held in April last, showed an increase of some 1,500. For the second division, however, held in May and June, the falling-off was very large and amounted to nearly 7,700.

The examinations this year, as last, have, in consequence of the falling-off in numbers, caused the Society a considerable financial loss. The same was the case last year, and the matter was fully discussed in last year's Report. The Society's Financial Statement for last year (1914-15) shows a difference of £875 to the bad, and this year (1915-16) there appears a difference of £1,035. This statement, as was explained, is unduly unfavourable in consequence of the time of the year when it is made up, which prevents the cost and the receipts of the same examination coming into the same balance-sheet. If similar figures are taken over a period of years it is possible to arrive at an accurate estimate of the cost of the examinations. Thus, taking the ten years before the war, a careful calculation shows that there was an average annual profit of about £100 during that period, and it was the existence of that profit which was thought to justify the Council in adopting the more expensive system of holding the examinations in two divisions in 1914.

But though the statement still holds good that in recent years the examinations have been made self-supporting, it is also the fact that the losses of the past two years have more than absorbed any previous profits, and, under existing conditions, the Society cannot undertake to provide a considerable annual subsidy to the examinations.

The Council have therefore felt justified in raising the fees by the addition of 6*d*. in the two lower stages, and 1*s*. in the Advanced Stage. The fees are still extremely moderate—3*s*. 6d., 3*s*., and 2*s*. 6*d*. respectively for the three stages, and it is not expected that any serious objection will be taken to them, or that the addition will have any appreciable effect in discouraging the entry of candidates.

The total number of entries for this year's examinations was 25,979—15,940 for the April examinations and 10,039 for those in May and June. The total shows a falling-off of 6,150 as compared with last year, when there were 32,129 entries. It should be understood that these figures represent, not the number of individual candidates, but the number of papers applied for. It will be noted that the entries for the first division of the examinations shows an increase of 1,523, and those for the second division a deficiency of 7,663.

The number of candidates who actually came up for examination was 19,315. These 19,315 candidates worked 24,002 papers—Advanced 2,797, Intermediate (including Theory of Music 230) 8,650, and Elementary 12,555. Comparing the number of papers worked with those applied for we find a difference of 1,977 or 7·2 per cent. It has always been rather a mystery why it is that so large a proportion should fail to present themselves after entering and paying their fees. The percentage this year is rather smaller than usual. Last year it was 8·1.

The numbers of papers worked were divided between the two examinations as follows :—

	April.	May-June.	Total.
Advanced Stage .	1,343	1,454	2,797
Intermediate Stage	4,315	4,335	8,650
Elementary Stage.	9,125	3,430	12,555
	14,783	9,219	24,002

In addition to the 19,315 examined in the annual examinations there were 380 candidates in Colloquial Modern Languages. The total number of candidates who were examined in all subjects by the Royal Society of Arts during the year ending July last, was, therefore, 19,695. Last year there were 23,722.

The general results of this year's examinations are given in Table A (page 842), and a comparative view of the numbers in the higher stages for the last six years (1911-16) is given in Table B (page 843). Tables C and D (page 844) show the percentage of successes and failures in all subjects of the two higher stages for the present year; while the percentage of successes and failures in all stages for the past six years are to be found in Table E (page 844). Table F (page 844) gives the number of candidates, papers, and subjects in the Elementary Stage since 1905. Table G (page 844) shows the number of papers worked in all stages during the last twelve years. Tables H and I (page 845) show the percentage of failures in the different subjects of the two higher stages for the last six years. Table K (page 846) gives the numbers of candidates examined during the same period. In Table L (page 846) are shown the results of the Viva Voce Examinations held at various centres during the current year.

The commercial subjects included Book-keeping, Accounting, Banking, Shorthand, Typewriting, Economic History and Theory,

Précis-writing, Theory and Practice of Commerce, Commercial Law, Company Law, Economic Geography, Arithmetic, Commercial Correspondence, etc., Handwriting, etc., English, French, German, Spanish and Italian. The other subject of examination was Music, divided into Rudiments of Music and Harmony.

It was announced in last year's Programme that it might possibly be necessary to discontinue the offer of medals and prizes during the continuation of the war. After consideration of the subject, the Council reluctantly decided to abandon the money prizes; but they were enabled, by the liberality of the Court of the Clothworkers' Company, to continue the offer of medals as usual. For many years the Clothworkers' Company has presented the Society with the sum of £40 to be expended in prizes for certain specified subjects, and the Court very kindly acceded to a request from the Council that they would permit their grant to be applied generally for the purpose of providing medals in all the subjects, instead of special prizes in selected subjects.

The Society was therefore enabled this year to award nineteen Silver and thirty-three Bronze Medals, the former in the Advanced Stage and the latter in the Intermediate. The scholarship offered annually by the London School of Economics was not awarded this year.

It was always a source of complaint that candidates had to wait a long time before they could know the results of their examinations. A new system of publication of the results of the examinations was started last year, and as it was much appreciated it has been continued. The candidates fill in a counterfoil attached to the paper on which they do their work; on these counterfoils the result of the examination is marked, and they are returned to the centres as soon as possible. By this means candidates are informed of the result of their examination some weeks sooner than in former years, when they had to wait until all the papers had been reported on and classified, and the printed results issued.

The results of the April examinations were sent to the centres concerned—the Advanced on June 21st, the Intermediate on June 30th, and the Elementary Stage on July 20th.

The results of the May-June examinations were issued—the Advanced Stage on August 2nd, the Intermediate on August 18th, and the Elementary on August 24th. The complete list of all the results, classified under localities, was published in October.

No alterations of importance were made in the Programme for last year; but after its issue two interesting additions were made an examination for English prisoners abroad and one for Belgian refugees. After a good deal of negotiation, it was found possible to provide examinations for some of the interned prisoners at Ruhleben, in Germany, and at Groningen, in Holland. In both cases no fees were charged.

As regards Groningen there was no special difficulty, and examinations were arranged for both divisions of the examinations. In both cases the papers of questions were sent over by the Foreign Office to H.M. Minister at the Hague, who kindly undertook to transmit them to the committee formed at Groningen for the supervision of the Examinations. 29 candidates entered—11 for the Advanced Stage, 13 for the Intermediate, and 5 for the Elementary. They worked 34 papers, of which 29 were passes and 5 failures. The subjects were Accounting, Book-keeping, Music, French, German, and Spanish.

At Ruhleben the conditions were more difficult; but the difficulties were overcome by the kind help of the Board of Education, who were able to get the packets of papers through without their being opened by the Censor. The local arrangements were not completed in time for the April examination, but for the Second Division, held in May and June, 31 candidates entered—17 Advanced, 11 Intermediate, and 3 Elementary. There were 41 papers, and only a single failure. The subjects were Book-keeping, Shorthand, English, French, German, and Spanish. Some of the work done was extremely good, and all was satisfactory.

In response to a suggestion from one of the local centres, an examination in English was arranged for Belgian refugees, and this proved extremely successful.*

It was thought better to charge the usual fees. But the work of setting the papers and marking the answers was done gratuitously, and the fees usually paid to the examiner were handed over to a Belgian charity.

In last year's Report an attempt was made to ascertain the comparative number of male and female candidates. The result was to show a percentage of 52·85 male and 47·15 female on the whole list; while in London the percentage was 52·50 female and 47·50 male. It has not been considered necessary to make a similar detailed examination of the present list; but a general estimate seems to show that the proportion of female names is much larger than last year, and now considerably exceeds that of male names. As regards London, the

* See infra, page 839.

number of females is considerably ahead of the number of males, and shows a great advance on last year.

It is also interesting to note that of the 52 medals awarded by the Society this year, 27, or more than half, were taken by women—who obtained 7 of the 19 Silver Medals awarded in the Advanced Stage, and 20 of the 33 awarded in the Intermediate.

The most popular subject is still Book-keeping, although the number of candidates in this subject (6,687) is not very much more than half the number of two years ago, when there were nearly 12,000 candidates. Last year the numbers fell to 8,960, so that there is a diminution of over two thousand in the present year. The examiner reports that the general standard in all stages was fully maintained, or on the whole a little improved.

As is always the case, the next most popular subject was Shorthand. In this 5,532 candidates were examined, as compared with 6,539 last year and 7,815 the year before. Roughly speaking, this shows a loss each year of a thousand. In Stage III. the percentage of passes, both first and second class, was considerably higher than last year. In Stage II. the standard seems to have been very much the same as in 1915, there being a slight falling-off in the number of first-class certificates and a slight improvement in the number of second. Stage I. also shows a little advance.

The entries in Typewriting this year show a slight increase upon last year, there being 2,638, or 72 more than the 2,566 of 1915; but they are still behind 1914, when they were 2,806. This was the largest number ever examined. In the Advanced Stage the work was on the whole excellent, and showed a marked improvement upon previous years; but as regards the Intermediate Stage the quality of the work submitted was much below that of previous years, and the same remark applies to the Elementary Stage. This result is curious and a little difficult of explanation.

In Arithmetic there had been before the war a steady and satisfactory growth in the numbers entering. Last year there was a falling-off of 419; this year the deficiency is larger, and amounts to 580. The actual numbers are 2,226 for the present year, 2,806 for last year, and 3,225 for 1914. On the whole, the working of the papers generally does not show any improvement.

English last year showed an actual increase in the number of papers worked; but this year there is a serious falling-off, as there were only 559 candidates as compared with 816—a loss of 257. It is very satisfactory to be able to report that the examiner considers that the average of the work done in all three stages compares favourably in quality with that of last year.

The new subject of English for Foreigners was added this year as the result of a suggestion from the Bradford educational authority that such an examination would be very useful to a number of the Belgian refugees in this country. Arrangements were therefore made for an examination in this subject to be held in Stages I. and II. at the April examinations. The result was extremely satisfactory, for 197 entered for the Elementary and 85 for the Intermediate Stage. As it was difficult to know what the standard of education would be, the paper in Stage I. was rather easy, and the result was that of the 197 candidates 165 passed. A considerable proportion of these papers were extremely good, and the candidates could easily have taken the Intermediate Stage. 85 entered for Stage II., and of these 23 obtained a first-class and 44 a second, while 18 failed. The result of this examination seemed to show that there might be a demand for an Advanced Stage paper for the May-June examination, and accordingly one was set. It appears that the fact was not very well known among the candidates, for only 12 entered. Of these only half passed, three taking a first-class and the other three a second. The paper set was really a rather difficult one, and apparently it was above the powers of most of those entering. For Stage II. there was a large entry—204. Of these 23 did not succeed in passing, 36 took a first-class, and 145 a second. For Stage I. 49 entered and 41 passed. On the whole, the result of the experiment was a distinct success, and the examination in this subject will be repeated next year.

It is not, perhaps, a matter for surprise, but it is certainly one for regret, that in nearly all what may be looked upon as the higher subjects in the Society's examinations the falling-off in the number of candidates has been very marked. This falling-off without much doubt is to be attributed to the fact that the candidates who entered for these subjects are all, or nearly all, young men of the age called upon for military service. The class of papers referred to includes those in Economics, Law, and Finance.

In Economic Geography there were not enough candidates in the Advanced Stage to justify the setting of a paper, and only 23 entered for the Intermediate. Last year was not quite so bad, as there were 18 in Stage III. and 38 in Stage II. In the Elementary Stage the deficiency is less noticeable—there were 157

against 190 last year. The total number of candidates is 180, or a deficiency of 66 on the 246 of last year. The quality of the work on the whole appears to be a little, but not very much, inferior to that of last year.

In Economic History there were no candidates at all—at least, there were not enough to justify the setting of a paper. Last year there were 103 in Theory and 24 in History—127 in all. This year we have only 46 in Economic Theory —18 in Stage III. and 28 in Stage II. The work was, on the whole, of fair quality and of a good general average.

For Commercial Law there were 57 entries, less than a third of the number last year. For Company Law there were only 49. The total number of entries in these two subjects, therefore, only amounts to 106. In 1915 there were 288, and in 1914, before the division of the subject into two, there were 308.

In Accounting there were 163 compared with 384 in 1915. In Banking there were 49 this year and 125 last. The total number in these two subjects, therefore, amounted to 212, whereas last year there were 509, and in 1914 the one subject of Accounting attracted 488. In Accounting the work, on the whole, was fairly good; several of the papers were excellent. In Banking the work appeared to be about the average, but there were no papers of particular merit.

In the important subject of the Theory and Practice of Commerce the results were more satisfactory than in the subjects just dealt with. For Stage III. there were 64 compared with 83 last year. For Stage II. 162 compared with 150 last year, this being one of the few instances of an increase in any stage of any subject. The total number of entries, therefore, was 226; last year there were 233. The character of the work, on the whole, is reported as quite satisfactory. Though the number of first-class papers is small, the number of absolute failures is not excessive.

For some years past the subject of Précis-writing has shown a steady decline, which, in the present year, is accentuated. In 1914 there were 198 candidates; in 1915, 138; and in the present year, 74, of whom 18 were in Stage III. and 56 in Stage II. In 1911 there were as many as 362 candidates entered.

The number of entries for Commercial Correspondence and Business Training was higher last year than in either of the two years previous, as it reached 606. This year there is a falling-off to 463. The corresponding subject, Handwriting and Correspondence in the Elementary Stage, still attracts a large number of candidates, but the falling-off last year from 1,912 in 1914 to 1,666 has been repeated this year, the number being 1,384. In response to several applications it has been determined to include this subject in Stage III., and a paper will therefore be set in it next year. The title has been altered, and the subject in future will be known as "Commercial Correspondence and Office Organisation" in all three stages.

With regard to the examinations in modern languages, they show a falling-off in numbers very much corresponding with that of last year. In French the deficiency is considerably greater, as there were 500 less than last year, when there was a falling-off of 170. The total number of entries for 1916 was 2,285. As before, the numbers have decreased in all three stages. Naturally one would have expected that French would have shown a smaller diminution than other languages; but this has not been the case, and it is rather difficult to suggest a reason. Six years ago there were 3,647 candidates, and it looks as if the diminution is not wholly due to circumstances connected with the war. The character of the work appears to show an advance. Last year the examiner reported that the standard was rather higher than usual, and the same seems to be the case again this year.

Last year the number of German papers diminished by some 50 per cent., and the falling-off this year is practically the same. Only 270 papers were worked, the deficiency being 192. The diminution appears in all three stages. Such a falling-off in German, of course, is what was to be expected, and the question has been considered whether the examination should not be dropped entirely. It has, however, been thought best to continue it, and the subject will hold its place in next year's Programme as usual.

In Italian it is a little remarkable that there is actually an increase, though the numbers are still small. Last year there were 44, and this year there were 61. The work on the whole in this subject, as it generally has been, is good.

In Spanish there were 149, as compared with 227 last year. The examiner reports favourably on the work in the two lower stages, but that sent in in Stage III. was disappointing.

The results of the Russian examination are remarkable. For nearly thirty years we have had examinations in Russian, but the number of entries has always been very small, and last year the examination was discontinued in consequence of the paucity of candidates. This year, however, classes were established under the London County Council and by independent institutions in London;

and so a special notice was sent round to the various Russian classes drawing the attention of the teachers to the Society's examination. The result was that 127 candidates entered—24 in the Intermediate Stage and 103 in the Elementary. No examination was held in Stage III. 82 of these passed, and 45 failed. The large proportion of failures is not remarkable, considering that practically all the students commenced their study of the language last year. The results, however, show much promise for future years.

Two interesting additions were made to the list of Modern Languages in which Viva Voce Examinations were held this year. For the benefit of Belgian refugees an examination was held in English for Foreigners, and, as a consequence of the increased study of Russian in this country, the experiment was tried of holding one in Russian. Both were held only in London, as no provincial centre was able to find a sufficient number of candidates for a local examination.

As was the case last year, there were also oral examinations in French, German, and Spanish, all in the London district—except at Manchester, where a small number of candidates were examined in French. In all 380 candidates were examined, 10 in Manchester and the rest in London; of these 321 passed, 141 with distinction, and 59 failed. The numbers in the different languages were—French 259, German 34, Spanish 15, Russian 19, English 53. In former years there were also examinations in Portuguese and Italian, and at Liverpool, Birmingham and Bristol.

The total number, 380, is much the smallest of any recent year, and shows a falling-off of 48 as compared with the 428 of 1915.

The oral examinations were started in 1902, when 280 candidates were examined. The numbers rose to 681 in 1905; after that there was a small diminution, the numbers varying slightly year by year, and falling to 583 in 1911, then they increased again to 688 in 1913, and this was the highest point yet reached, as in 1914 there was a drop to 628. Table L (page 846) gives in detail the results of this year's examinations.

The oral examinations are held at any of the Society's centres where the necessary arrangements can be made, at any date convenient to the local committee. The examination includes dictation, reading, and conversation, and is so arranged as to test efficiency in colloquial knowledge of the language, without laying too much stress on minute grammatical accuracy. Candidates who are reported upon as highly qualified by the examiners receive a certificate of having passed with distinction.

The examinations in Rudiments of Music and Harmony were carried on as usual at the same time as the Commercial examinations, and the results appeared as part of the results of the Intermediate Stage. The total number of candidates was only 230, less than half the number, 509, of last year. So sudden and serious a diminution may without doubt be attributed to the war; but as noted in last year's Report, the falling-off in the number of candidates attracted by this subject has been steady and continuous for many years. This is clearly shown by the figures, which were quoted last year, and may now be repeated. They are—509 in 1916, 587 in 1914, 617 in 1913, 688 in 1912, 691 in 1911, 619 in 1910, 699 in 1909, 716 in 1908, 641 in 1907, and 637 in 1906.

In Rudiments of Music 116 candidates presented themselves; last year there were 254. In Harmony there were 114, as compared with 255. Of the 116 candidates in Rudiments of Music, 90 passed and 26 failed. Of the 114 candidates in Harmony, 80 passed and 34 failed. The results show a falling-off from the standard of recent years. So it looks as if the candidates were not only less numerous, but less efficient.

The Examination Programme for 1917 was issued early in October. In it will be found the fullest possible information about the examinations, a syllabus of each stage of each subject, and the papers set in May-June, 1916.* The attention of both teachers and students may be drawn once more not only to the syllabuses but also to the remarks of the various examiners on the results of last year. It will be found that these contain many valuable and helpful suggestions, and the work of the candidates year after year shows that far too little attention is paid to them. Teachers especially are earnestly recommended to study these remarks, as they ought to be guided by them in the instruction they give to their pupils.

The regulations for the Examinations in the Theory of Music, and those for the Viva Voce Examinations in Modern Languages, are also given in full length.

* The price of the Programmes for 1914, 1915, 1916, and 1917 is 4*d*. each, post free 6*d*. Copies can be obtained on application to the Secretary of the Royal Society of Arts, Adelphi, London, W.C. Programmes containing the papers set from 1905 to 1912 can also be obtained (price 3*d*. each year, post free 4½*d*.). The papers set in March, 1915, and April, 1916, are not included in the 1916 and 1917 Programmes. They are printed in separate pamphlets, price 2*d*. each (post free 3*d*.). The regulations and syllabuses for the present year can also be had separately (without the papers), price 1*d*., by post 1½*d*.

TABLE A.—DETAILS OF THE 1916 EXAMINATIONS.

Subjects.	Stage III.—Advanced. Papers worked.	Stage III. 1st class certificates.	Stage III. 2nd class certificates.	Stage III. Not passed.	Stage II.—Intermediate and Music. Papers worked.	Stage II. 1st class certificates.	Stage II. 2nd class certificates.	Music Certificates. Higher.	Music Certificates. Inter-mediate.	Music Certificates. Elemen-tary.	Stage II. Not passed.	Stage I.—Elementary. Papers worked.	Stage I. Passed.	Stage I. Not passed.	Total number of papers worked in all stages.
Arithmetic	70	11	24	35	438	44	211	..	..	..	183	1,718	1,010	708	2,226
English	18	3	10	5	151	29	87	..	..	..	35	390	248	142	559
Book-keeping	879	114	405	360	2,209	426	1,219	..	..	..	564	3,599	2,245	1,354	6,687
Economic Geography	..	..	..	..	23	1	10	..	..	..	12	157	100	57	180
Shorthand	511	65	325	121	2,747	585	1,150	..	..	..	1,012	2,274	1,635	639	5,532
Typewriting	166	59	84	23	788	146	453	..	..	..	189	1,684	882	802	2,638
English for Foreigners	12	3	3	6	289	59	189	..	..	..	41	246	206	40	547
Economic Theory	18	1	15	2	28	4	19	..	..	..	5	..	..	..	46
Précis-writing	18	4	13	1	56	19	34	..	..	..	3	..	..	..	74
Commercial Correspondence and Business Training	..	..	..	..	463	36	262	..	..	..	165	..	..	..	468
Commercial Law	57	6	35	16	..	..	..	..	..	..	..	..	..	..	57
Company Law	49	6	25	18	..	..	..	..	..	..	..	..	..	..	49
Accounting	163	32	85	46	..	..	..	..	..	..	..	..	..	..	163
Banking	49	7	25	17	..	..	..	..	..	..	..	..	..	..	49
Theory and Practice of Commerce	64	9	42	13	162	13	85	..	..	..	64	..	..	..	226
French	591	107	356	128	853	123	553	..	..	..	177	841	511	330	2,285
German	70	30	32	8	117	28	69	..	..	..	20	83	66	17	270
Italian	20	11	3	6	21	6	7	..	..	..	8	20	14	6	61
Spanish	42	4	28	10	51	16	24	..	..	..	11	56	40	16	149
Russian	..	..	..	..	24	7	15	..	..	..	2	103	60	43	127
Handwriting and Correspondence	..	..	..	..	..	..	..	..	..	..	..	1,384	873	511	1,384
Rudiments of Music	..	..	..	..	116	..	..	46	..	44	26	..	..	..	116
Harmony	..	..	..	..	114	..	..	11	80	39	34	..	..	..	114
Totals	2,797	472	1,510	815	8,650	1,542	4,387	57	80	83	2,551	12,555	7,890	4,665	24,002

TABLE B.—NUMBER OF PAPERS WORKED IN EACH SUBJECT OF STAGES III. AND II. IN 1911-12-13-14-15-16.

SUBJECTS.	1911.			1912.			1913.			1914.			1915.			1916.		
	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.
Arithmetic	177	731	908	93	690	783	93	669	762	132	733	865	118	659	777	70	438	508
English	134	351	485	87	357	444	63	303	366	78	271	349	53	260	313	18	151	169
Book-keeping	2,265	4,287	6,552	2,156	4,127	6,283	2,179	4,118	6,297	2,469	4,295	6,764	1,690	3,267	4,957	879	2,209	3,088
Commercial History and Geography	47	84	131	24	60	84	19	44	63	13	41	54	..	..	..	..	..	..
Economic Geography	..	..	..	..	..	..	..	..	..	..	..	..	18	38	56	..	23	23
Shorthand	867	4,344	5,211	774	4,120	4,894	755	4,174	4,929	740	4,134	4,874	562	3,449	4,011	511	2,747	3,258
Typewriting	222	887	1,109	224	885	1,109	213	824	1,037	244	974	1,218	200	931	1,131	166	788	954
English for Foreigners	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	12	289	291
Economics	55	83	138	59	91	150	55	110	165	64	94	158	..	..	..	..	..	..
Economic History	..	..	..	..	..	..	..	..	..	..	..	..	14	10	24	..	..	..
Economic Theory	..	..	..	..	..	..	..	..	..	..	..	..	47	56	103	18	28	46
Précis-writing	94	268	362	72	144	216	63	98	161	66	132	198	58	80	138	18	56	74
Theory and Practice of Commerce	..	..	..	..	..	..	..	..	..	76	78	154	83	150	233	64	162	226
Commercial Correspondence and Business Training	..	303	303	..	454	454	..	603	603	..	583	583	..	606	606	..	463	463
Commercial Law	247	..	247	380	..	380	297	..	297	308	..	308	184	..	184	57	..	57
Company Law	..	..	..	..	..	..	..	..	..	..	..	..	104	..	104	49	..	49
Accounting and Banking	499	..	499	476	..	476	490	..	490	488	..	488	..	..	..	..	..	..
Accounting	..	..	..	..	..	..	..	..	..	..	..	..	384	..	384	163	..	163
Banking	..	..	..	..	..	..	..	..	..	..	..	..	125	..	125	49	..	49
French	967	1,488	2,455	793	1,497	2,290	756	1,293	2,049	793	1,181	1,974	756	1,063	1,819	591	853	1,444
German	212	354	566	224	332	556	197	303	500	188	280	468	109	176	285	70	117	187
Italian	25	28	53	20	12	32	17	22	39	23	33	51	13	20	33	20	21	41
Spanish	81	90	171	73	97	170	72	86	158	117	92	209	74	76	150	42	51	93
Portuguese	16	16	32	14	10	24	13	15	28	20	9	29	..	..	..	..	..	..
Russian	4	6	10	2	8	10	3	8	11	8	9	17	..	..	..	..	24	24
Danish and Norwegian	10	5	15	6	6	12	5	5	10	3	4	7	..	..	..	..	..	..
Hindustani	2	3	5	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..
Swedish	7	4	11	6	..	6	3	3	6	..	4	4	..	..	..	..	..	..
Japanese	..	2	2	..	5	5	..	..	..	..	..	..	..	..	..	..	..	..
Chinese	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Arabic	..	..	..	..	..	..	..	7	7	..	3	3	..	..	..	..	..	..
Dutch	..	..	..	..	..	..	..	..	..	2	6	8	..	..	..	..	..	..
Totals	5,931	13,334	19,265	5,483	12,895	18,378	5,293	12,685	17,978	5,832	12,957	18,789	4,592	10,841	15,433	2,797	8,420	11,217

Table C.

Percentages of Successes and Failures, Advanced Stage, 1916.

	First-class.	Second-class.	Failures.
Arithmetic	15·71	34·29	50·00
English	16·66	55·56	27·78
Book-keeping	13·08	45·96	40·96
Shorthand	12·72	63·60	23·68
Typewriting	35·55	50·60	13·85
English for Foreigners	25·00	25·00	50·00
Economic Theory	5·55	83·33	11·12
Précis-writing	22·23	72·22	5·55
Commercial Law	10·53	61·40	28·07
Company Law	12·25	51·02	36·73
Accounting	19·63	52·15	28·22
Banking	14·28	51·02	34·70
Theory and Practice of Commerce	15·63	64·06	20·31
French	18·10	60·24	21·66
German	42·86	45·71	11·43
Italian	55·00	15·00	30·00
Spanish	9·52	66·66	23·82

Table D.

Percentages of Successes and Failures, Intermediate Stage, 1916.

	First-class.	Second-class.	Failures.
Arithmetic	10·05	48·17	41·78
English	19·20	57·62	23·18
Book-keeping	19·29	55·18	25·53
Economic Geography	4·34	43·48	52·18
Shorthand	21·28	41·84	36·88
Typewriting	18·53	57·49	23·98
English for Foreigners	20·42	65·40	14·18
Economic Theory	14·28	67·86	17·86
Précis-writing	33·94	60·71	5·35
Commercial Correspondence and Business Training	7·77	56·59	35·64
Theory and Practice of Commerce	8·02	52·47	39·51
French	14·42	64·82	20·76
German	23·93	58·97	17·10
Italian	29·00	33·00	38·00
Spanish	31·37	47·07	21·56
Russian	29·18	62·50	8·32

Table E.

Percentages of Successes and Failures in all Stages, 1911–12–13–14–15–16.

Advanced (Stage III.).

	1911.	1912.	1913.	1914.	1915.	1916.
First-class	11·64	11·42	14·70	13·92	15·57	16·[illegible]
Second-class	48·15	47·09	58·17	50·19	52·44	53·9[illegible]
Failures	40·21	41·49	27·13	35·89	31·99	29·1[illegible]

Intermediate (Stage II.).

	1911.	1912.	1913.	1914.	1915.	1916.
First-class	15·78	15·27	10·88	15·13	19·92	1[illegible]
Second-class	56·00	55·91	58·18	52·79	51·12	52·1[illegible]
Failures	28·22	28·82	30·94	32·08	28·96	29·5[illegible]

Elementary (Stage I.).

	1911.	1912.	1913.	1914.	1915.	1916.
Passes	64·69	64·99	61·08	63·46	66·28	62·84
Failures	35·31	35·01	38·92	36·54	33·72	37·16

Table F.

Elementary Examinations, Stage I. 1905 to 1916.

Year.	No. of candidates.	No. of papers worked.	No. of subjects.
1905	7,397	8,427	10
1906	7,425	8,537	10
1907	7,692	8,952	10
1908	8,276	9,811	10
1909	9,196	11,069	10
1910	10,289	12,720	10
1911	11,277	14,286	10
1912	11,448	14,936	10
1913	11,096	14,611	10
1914	12,104	16,046	11
1915	10,000	13,584	11
1916	9,297	12,555	13

Table G.

Number of Papers Worked in all Stages, 1905 to 1916.

	Stage III.	Stage II.	Stage I.	Total.
1905	4,844	10,533	8,427	23,804
1906	4,904	10,734	8,537	24,175
1907	4,815	10,802	8,952	24,569
1908	4,795	11,199	9,811	25,805
1909	5,433	12,512	11,069	29,014
1910	5,309	12,848	12,720	30,872
1911	5,931	14,025	14,286	34,242
1912	5,483	13,583	14,936	34,002
1913	5,293	13,302	14,611	33,206
1914	5,882	13,544	16,046	35,42[illegible]
1915	4,592	11,350	13,584	29,526
1916	2,797	8,650	12,555	24,002

The numbers for Stage II. include the papers set in Music.

TABLE H.

PERCENTAGES OF FAILURES IN ALL SUBJECTS, ADVANCED STAGE, 1911-12-13-14-15-16.

	1911.	1912.	1913.	1914.	1915.	1916.
Arithmetic	45·76	50·52	50·53	58·00	40·68	50·00
English	34·33	48·27	41·27	32·05	33·96	27·78
Book-keeping	45·21	49·12	26·48	36·45	37·10	40·96
Commercial History and Geography	51·10	37·50	21·05	46·15	..	..
Economic Geography	..	..	..	..	38·90	..
Shorthand	60·32	60·73	25·30	63·11	39·50	23·63
Typewriting	24·78	32·59	27·70	34·43	33·50	13·85
English for Foreigners	..	..	..	..	..	50·00
Economics	45·46	25·42	14·54	18·75	..	..
Economic History	..	..	..	..	14·50	..
Economic Theory	..	..	..	..	19·00	11·12
Précis-writing	30·86	29·17	26·98	30·30	34·48	5·55
Commercial Law	45·35	35·00	38·38	35·39	38·04	28·07
Company Law	..	..	..	..	31·73	36·73
Accounting and Banking	27·25	28·56	27·35	27·26	..	..
Accounting	..	..	..	..	22·91	28·22
Banking	..	..	..	..	25·60	34·70
Theory and Practice of Commerce	..	..	..	34·20	36·15	20·31
French	22·96	22·07	19·84	18·66	18·91	21·66
German	32·10	31·25	41·12	28·19	20·18	11·43
Italian	12·00	10·00	11·77	13·05	23·11	30·00
Spanish	35·80	23·30	33·34	22·22	35·14	23·82
Portuguese	25·00	14·29	7·72	10·00	..	..
Russian	0·00	0·00	0·00	0·00	..	..
Hindustani	0·00	..	..	..	..	..
Danish and Norwegian	30·00	0·00	0·00	0·00	..	..
Swedish	14·00	50·00	33·34	0·00	..	..
Dutch	..	..	..	100·00	..	..

TABLE I.

PERCENTAGES OF FAILURES IN ALL SUBJECTS, INTERMEDIATE STAGE, 1911-12-13-14-15-16.

	1911.	1912.	1913.	1914.	1915.	1916.
Arithmetic	32·97	29·71	27·95	28·78	28·98	41·78
English	28·49	28·57	36·30	21·77	29·62	23·18
Book-keeping	32·63	33·44	26·52	25·28	25·86	25·53
Commercial History and Geography	36·91	26·66	27·27	34·15	..	..
Economic Geography	..	..	..	..	34·21	52·17
Shorthand	25·27	23·18	40·10	45·50	36·42	36·88
Typewriting	28·07	34·01	25·97	33·58	21·59	23·98
English for Foreigners	..	..	..	..	..	14·18
Economics	16·87	15·38	15·45	16·00	..	..
Economic History	..	..	..	..	10·00	..
Economic Theory	..	..	..	..	7·14	17·86
Précis-writing	29·11	25·70	22·45	25·76	30·00	5·35
Theory and Practice of Commerce	..	..	..	29·50	47·34	39·51
Commercial Correspondence and Business Training	31·68	34·36	31·67	21·27	31·02	35·64
French	22·45	25·05	18·64	20·32	18·53	20·76
German	21·47	39·76	42·90	33·22	30·68	17·10
Italian	17·86	16·67	22·73	21·22	20·00	38·00
Spanish	34·44	28·86	23·26	32·61	19·74	21·56
Portuguese	31·25	60·00	40·00	55·56	..	..
Russian	33·34	37·50	0·00	22·23	..	8·32
Danish and Norwegian	0·00	33·33	20·00	0·00	..	..
Swedish	75·00	..	66·66	50·00	..	..
Japanese	100·00	60·00	..	..	..	..
Hindustani	33·34	..	..	100·00	..	..
Chinese	..	..	..	..	..	..
Arabic	..	..	42·86	0·00	..	..
Dutch	..	..	..	33·34	..	..

TABLE K.

CANDIDATES EXAMINED IN 1911-12-13-14-15-16.

	1911.	1912.	1913.	1914.	1915.	1916.
Commercial Knowledge—						
Stage III.—Advanced	5,134	4,754	4,618	5,065	3,715	2,624
Stage II.—Intermediate (including Theory of Music) . . .	12,233	11,855	11,580	11,873	9,554	7,394
Stage I.—Elementary	11,277	11,448	11,096	12,104	10,000	9,297
Totals	28,644	28,057	27,294	29,042	23,269	19,315
Music (Practice)	283	296	273	244	—	—
Colloquial Modern Languages . .	583	633	688	628	453	380
Army Candidates	64	45	54	57	—	—
Totals in all Subjects . .	29,574	29,031	28,309	29,971	23,722	19,695

TABLE L.

VIVA VOCE EXAMINATIONS HELD DURING 1916.

Centre of Examination.	Date.	Number of Candidates.	Passed with Distinction.	Passed.	Failed.
French :—	1916.				
Manchester Education Committee	April 18 .	10	3	4	3
Enfield County School	May 9 .	45	10	27	8
Kensington College	May 11 .	33	13	15	5
Pitman's School	May 16 .	26	10	14	2
City of London College	May 17 .	20	6	11	3
Regent Street Polytechnic	May 18 .	22	9	7	6
Pitman's School (Candidates from London Institutions) . .	May 19 .	24	12	8	4
City of London College (Candidates from London Institutions).	May 24 .	23	4	13	6
Acton and Chiswick Polytechnic	June 8 .	27	6	16	5
St. Clement Danes' School (Candidates from L.C.C. Institutes)	June 22 & 23	29	10	14	5
German :—					
Pitman's School (Candidates from London Institutions) . .	May 22 .	17	9	5	3
City of London College (Candidates from London Institutions).	May 25 .	17	11	4	2
Spanish :—					
City of London College (Candidates from London Institutions)	June 1 .	15	2	10	3
Russian :—					
City of London College (Candidates from London Institutions).	June 14 .	19	2	14	3
English for Foreigners :—					
Highbury L.C.C. Institute (Candidates from L.C.C. Institutes) St. Clement Danes' School (Candidates from L.C.C. Institutes)	June 19 & 20	53	34	18	1
Totals		380	141	180	59

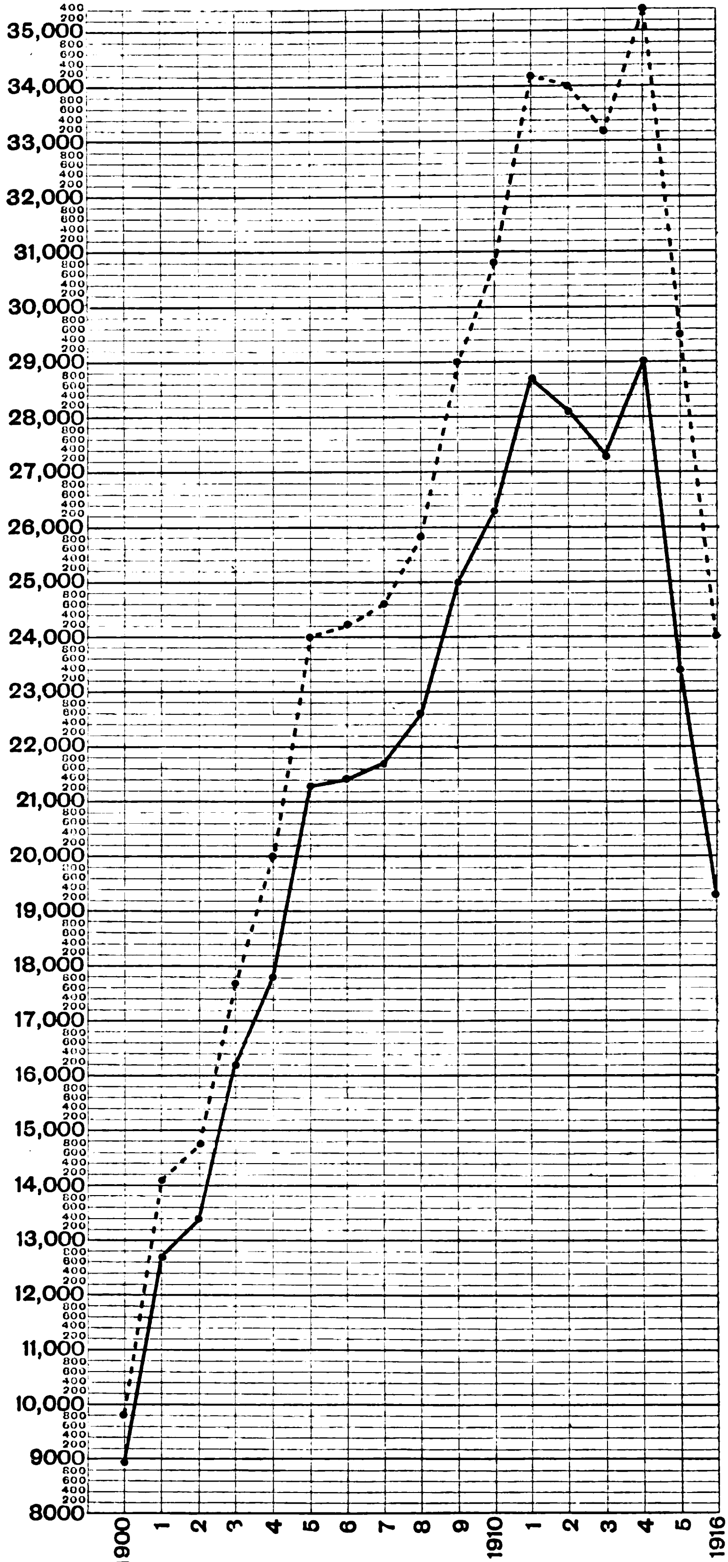

DIAGRAM SHOWING PROGRESS OF EXAMINATIONS, 1900-1916.
The solid line shows the number of candidates, the dotted line the number of papers worked.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Industrial Intelligence.—It must be hoped that in their own good time the ruling authorities will see fit to summarise for publication the new facts gained from their several inquiries into the state of the textile industries. These inquiries have had reference in especial to the textiles necessary for war, and they have elicited much that previous returns have not contained. Details of the number and kind of machines, their maximum capacity and average output, have not hitherto been obtainable, and these will be of no less interest than the statements of the quantities of materials on hand at given dates. Traders have been at considerable pains to provide the information, and they should not be deprived of the benefit of reading the outcome in print and of correcting their ideas accordingly. The competent authorities will have to decide whether the periodical renewal of such inquiries is a necessary part of the future national organisation for war. Conceivably it will be found that the form of the census of production, or of the factory returns taken up at ragged intervals by the Home Office, require some change.

British "Inefficiency."—Apart from their other uses, closer particulars of the work done in British textile factories may do something for the British name for efficiency. The new book "Eclipse or Empire," reproduces a sadly fallacious set of tables from which the reader is asked to believe that in productive power the American textile operative is the equal of from one and a half to three English wage-earners. It is stated, for example, that the net weekly produce of a silk worker in the United Kingdom is £1 1*s.* 2*d.*, against the average £3 9*s.* 3*d.* in the United States. Even if the figures are as accurate as the industry of census compilers can make them, they are valueless for comparative purposes, because they do not relate to the same form of work. The similarity between the American and English silk industries is in their name, not in their nature, and there is no possibility of illumination from comparisons which fail to distinguish between such essentially different commodities as silk yarn and silk cloth. In the same way there is no excuse for treating American and British cottons as identical articles. The same chapter in the glossary of the book avers that in the use of the most modern and most perfect labour-saving machinery, the American cotton industry was far ahead of the British five years ago. The basis of this extraordinary assertion is a comparison of the number of automatic looms in use in the two countries; but the outsider may be assured that the Lancashire manufacturer is still pursuing his policy of using that machine which gives the best return for his money. If American experience runs counter to English, something must be allowed for local circumstance. It does not follow that either party is in the wrong.

Marine Silk.—The question has been asked. "What is marine silk (*byssus*), the exportation or re-exportation of which has been prohibited from France?" The answer is indiscoverable in the ordinary way of trade, and it cannot be affirmed of knowledge that the material has any modern use. Porter, in his Treatise, quotes a writer of 1782, who had seen "a strong, brown silk, belonging to some sort of shell, of which they make caps, gloves, stockings, waistcoats, etc., warmer than the woollen stuffs, and brighter than common silk." The description makes it seem the more singular that so meritorious an article should have dropped out of use, and it may be supposed that the account is in some ways deficient. Aristotle knew byssus, and described it as the beard of the pinna, which is a large shell-fish of the mussel family. The pinna secretes a viscid matter in innumerable filaments, and by means of these steadies itself against the movement of the water. Byssus was manufactured in the kingdom of Naples and in Palermo, and it is recorded that in 1754 marine silk stockings were presented to Pope Benedict XIV. Snuff-boxes are not necessarily of one size, but it is said that a pair of byssus stockings could be easily contained in a snuff-box. The article is mentioned presumably by force of habit in French proclamations in company with the recognised sorts of silk.

The Next Carpets.—Fashion in carpets is apparently on the brink of change, the Persian *motifs* having been exhausted nearly as thoroughly as the variants upon Voysey's acanthus leaves. The new sources of inspiration are also Eastern, and as they open up a rich lode of adaptable material it is probable that they will provide a long run. Springtime is the season at which new carpets appear before the public, but the preparations for that period are well forward, and it can be said that the drawing-room carpets for next year will include a choice of Chinese and Egyptian designs. There will be willow-pattern Axminsters in blue and white, and tawnier carpets with recognisably Chinese figures for ornament. The sphinx is an obviously adaptable object for carpet designs, and there is material enough associated with the Nile to allow innumerable changes to be rung upon Egyptian themes. Apparently "verdure" carpets with black or grey backgrounds will again be prominent. Carpets are both up in prices and down in quality, as judged by peace standards, and the deterioration is in part involuntary—a consequence of the inability to get the same yarns and colours as before. Materials are so dear that a good deal has been deliberately taken out of the fabrics to bring them within the limits of the purse, and it rests to be seen whether the old standards will ever be restored. The expense of double dyeing

has put an end temporarily to the production of improved printed carpets for bedrooms, in which a relatively high standard of taste was applied to a cheap kind of goods. Manufacturers note a steady but slow progression towards higher art in carpets for the artisan's home. New patterns in printed carpets cost a large sum of money, and must sell in quantities in order to become profitable. The producer is thus tied to the greatest common measure, and is not free to consult only the most advanced sections of his public.

Textile Research.—The Textile Institute continues its semi-annual congresses, and in its latest session at Leeds discussed principally science in its industrial application. Mr. J. H. Lester's paper bore the most directly upon textile as opposed to chemical manufacturers' problems. Scientists tend to be too abstract and manufacturers too concrete, so that it is advantageous to hear one who doubles these capacities. A chemist who for many years managed the Chamber of Commerce Testing House, Manchester, and is now scientific director of one of the largest Lancashire cotton firms, should be able to see from both sides. Mr. Lester's paper distinguished between the position of textiles and that of the magneto, optical glass and colour industries, and all its tenour was against haste and the expectation of quick returns from a sudden devotion to scientific research. He sketched a picture of confraternities of research workers in physics and chemistry worthily housed in the local centres of the industries they are to serve, and united less by mechanical organisation than by fellowship. Mr. Lester left it to others to formulate a definite scheme. It is, however, to be desired that some one should supply a picture of these researchers at their work, showing what they would do from day to day, with specimens of the kind of fact they would accumulate, and illustrations of the use to which their rarefied data would be put. The more actual the prospects can be made, the more enthusiasm they will evoke among the apathetic.

Current Difficulties.—Complaints are rife about the inattention of workpeople and the impossibility of maintaining discipline when any discharged worker can find new work at any moment. Carelessness quite openly breeds carelessness. Yarn comes in from the spinners with more than its due allowance of knots and thick places, and the effect is not to make the weaver more careful but less. It is said that standards of excellence have been relaxed, and that customers have to be thankful for such goods as may be sent; but to reach even these debilitated standards gives a large amount of trouble. Extra processes have to be employed to bring the resultant goods up to the mark, and these all occupy time and intensify vexation. The best-laid plans are sent awry, and manufacturers who thought they had protected themselves and their customers by allotting their production strictly *pro rata*, and by refusing to sell any goods they did not feel well able to deliver, find themselves three and four months behind their programme. The plight may not be universal, but at all events it is common; and it is a trying one for the health and temper, relieved though it may be by the facts of the balance-sheet.

OBITUARY.

Sir John William Pitt Muir-Mackenzie, K.C.S.I.—Sir John Muir-Mackenzie died at his residence in London on October 25th.

Born in 1854, he was educated at Eton, and passed into the Indian Civil Service in 1874. In 1883 he was deputed to study agriculture at the Royal Agricultural College, Cirencester, and ten years later he was sent to Réunion and Mauritius in connection with Coolie labour questions. He became Under-Secretary to the Government of India in the Revenue and Agricultural Departments, and subsequently Director of Agriculture. He also acted as Chief Secretary to the Government of Bombay, and Commissioner in Sind. He was a member of the Executive Council of the Government of Bombay from 1905 to 1910, when he retired from the Service, and he acted as temporary Governor in 1907. He was created K.C.S.I. in 1909.

Sir John became a member of the Royal Society of Arts in 1900, and he occasionally took part in discussions at meetings of the Indian Section.

Walter Hancock.—The Society has lost one of its oldest members by the death of Mr. Walter Hancock, which took place on October 17th.

Mr. Hancock was born at Aylesbury in 1831. He came of a remarkable family. His father, Charles, was well known as an artist and particularly as a painter of animals; but he was perhaps still better known for his work in connection with gutta-percha. He was the first to devise special machinery for cleansing and purifying the raw material, and he also took out the first patent for its practical application. It was at the Society of Arts that he obtained his first specimen for experiment, a piece having been given him at the *conversazione* held here in the winter of 1843-44 when Dr. Montgomerie's specimens were first exhibited.

Charles Hancock's two brothers were also well known in their day. Thomas's name was intimately associated with the earliest steps in the manufacture of india-rubber, for he was the inventor of the vulcanising process, which he patented in 1843. He also took a number of other patents in connection with the subject. The other brother, Walter, was an engineer who did much to promote the use of steam carriages on common roads, and also improved the machinery for india-rubber manufacture. The late Sir Frederick Bramwell was one of his pupils.

Walter Hancock, the subject of this notice, was educated at a private school, where one of his keenest competitors was James (afterwards Sir James) Knowles, the editor of the *Nineteenth Century*. At the age of fourteen he entered the engineering works, at Stratford, of his uncle, Walter Hancock. Young Hancock naturally devoted himself to machinery for gutta-percha manufacture, and was associated with his father at the works at West Ham and Smithfield. Subsequently he was connected with the India Rubber, Gutta Percha, and Telegraph Works Co., Ltd., and designed and built their gutta-percha factory and plant at Silvertown.

Mr. Hancock became a member of the Society of Arts in 1859, at the suggestion of Mr. Thomas Webster, Q.C., father of the late Lord Alverstone, who, like his son, took a very deep and active interest in the Society's work. He spoke for the first time in the Society's room in 1863, when he took part in the discussion on a paper on "Submarine Telegraphy," by Mr. Webster, and thenceforward he was a frequent speaker here, especially on papers connected with india-rubber, gutta-percha, and telegraphy. His last appearance in the meeting room was made in 1913 (exactly fifty years later), when he came to hear a paper by his son, Mr. Walter C. Hancock, on "The Physical Properties of Clays."

Mr. Hancock was an early member of the Institution of Telegraph (now Electrical) Engineers, and he served on the council of that body. He also took a deep interest in the work of the Self-Propelled Traffic Association, and was one of the deputation sent by that body, under the leadership of Sir David Salomons, to Mr. Henry Chaplin, President of the Local Government Board, in 1896. As a result of this the Light Road Locomotives Act was passed in that year, and the development of automobilism in this country was rendered possible.

GENERAL NOTES.

Kaolin Deposits in Paraguay.—According to a report by the United States Consul at Asuncion, there has recently been considerable interest evinced by Argentine capitalists in kaolin in Paraguay, in which country there are numerous large deposits. The principal one is situated at Tobati, thirty miles from the Paraguay Central Railway, and is estimated to contain 7,800,000 cubic yards of kaolin. The kaolin of this deposit is said to be of a good quality, suitable for the manufacture of china, etc. As yet, however, no extensive investigations of the extent of the deposits or of the properties of the kaolin have been made. It is stated that a company, with a capital of about £500,000, will be formed in Argentina to extract the kaolin from the Tobati district and to manufacture products therefrom.

Russian Phonetics.—A special course in Russian phonetics and their application to class teaching will be delivered by Mr. M. V. Trofimov, B.A. (Petrograd), lecturer in Russian at University of London King's College. The course will consist of thirty hours, and will be held on Wednesdays from 5 to 7 p.m., beginning on Wednesday, November 8th, 1916. On each day one hour will be devoted to theory and a second to practical demonstration and discussion. The class is specially designed for those who teach or wish to teach the Russian language in England, whether themselves of Russian or English nationality. The fee is two guineas for the course of thirty hours.

Black Damp in Mines.—The United States Bureau of Mines, in pursuing investigations looking to greater safety in mining, has analysed samples of the air in many different coal mines in the United States, and has studied the analyses. The results of one phase of this study are presented in Bulletin 105, "Black Damp in Mines." This study shows how atmospheric air, after entering a coal mine, loses oxygen and gains carbon-dioxide, with resulting formation of so-called black damp. The report also discusses the effects of the constituents of black damp on men, on the burning of oil and acetylene lamps, and on the explosibility of methane. Copies of this Bulletin may be obtained free of charge by addressing the Bureau of Mines, Washington, D.C.

Japanese Cotton Trade.—Japan's exports of cotton yarn have shown a large increase since the latter part of last year. According to the *Japan Chronicle's* report of investigations made by the Spinning Association, exports of various cotton cloths during the first half of this year amounted in value to $23,415,072. This figure is unprecedentedly large, and shows an increase of $4,123,467 over the amount for the preceding six months, and $10,966,488 over that of the corresponding period last year. The highest rate of increase was seen in the exports to India, followed by Siberia, while the exports to the Philippines decreased by about one-half as compared with the preceding half-year.

Basket-making at Nice.—A school for teaching the art of basket-making (*École de Vannerie*) to disabled soldiers and other disoccupied persons has been opened at Nice. Although opened barely three months ago, it already numbers 79 pupils. It is contemplated opening branch schools in other parts of the Department of the Maritime Alps, in order to encourage the art as a home industry, and so eventually to free the country from dependence on German goods, which previous to the war flooded the French markets to the extent of 80 per cent. Vast tracts of marshy country and other suitable waste land might be utilised for osier growers if a demand were created for materials for basket-making.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

ARRANGEMENTS FOR THE SESSION.

The Opening Meeting of the One Hundred and Sixty-Third Session will be held at 4.30 p.m. on Wednesday, November 15th, when an address will be delivered by DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, on "The Stability of Great Britain."

The following arrangements have been made for the meetings before Christmas:—

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

NOVEMBER 22.—LESLIE URQUHART, "The Economic Development of Russia and Britain's Share therein." The RIGHT HON. LORD CARNOCK, G.C.B., G.C.M.G., G.C.V.O., K.C.I.E., British Ambassador in Russia, 1906-1910, will preside.

NOVEMBER 29.—

DECEMBER 6.—C. M. WHITTAKER, B.Sc., "The Coal-Tar Colour Industry."

DECEMBER 13.—H. WILSON FOX, "The Development of Imperial Resources."

DECEMBER 20 (at 4 p.m.).—A. C. BENSON, C.V.O., Master of Magdalene College, Cambridge, "Classical and Scientific Education."

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

DECEMBER 14.—JOHN ALTON TODD, B.L., Professor of Economics, University College, Nottingham, "The World's Cotton Supply and India's Share in it." The RIGHT HON. LORD EMMOTT, P.C., G.C.M.G., will preside.

Papers to be read after Christmas:—

LAWRENCE CHUBB, Secretary to the Commons and Footpaths Preservation Society, "Highways and Footpaths."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

JAMES HARRIS VICKERY, LL.B., "German Business Methods."

CAPTAIN PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

OCTAVIUS C. BEALE, "British Arts and Crafts after the War."

COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "Between the Tigris and the Indus. The Ben-i-Israel."

SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

F. A. HOCKING, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

January 18, February 15, March 15, April 19, May 17.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

January 30, February 27, March 27, May 1.

HOWARD LECTURES.

Monday afternoons, at 5 p.m.:—

JOHN S. S. BRAME, Professor of Chemistry, Royal Naval College, Greenwich, "Coal and its Economic Utilisation." Three Lectures.

LECTURE I.—NOVEMBER 27.—The economic importance of coal—Enhanced importance in war time—Coal: the munition of war—The movement for economy—The output of coal and consumption

for various purposes—Duration of supplies and economical considerations in relation to other countries—Other alternative sources of energy.

Lecture II.—December 4.—Recent developments in knowledge of composition of coal—Coal as a heating agent—As source of power—For domestic heating, etc.—The by-products from coal distillation, their relation to industry, and particularly as raw materials for munitions of war.

Lecture III.—December 11.—Directions in which economy may be realised—Economy in production—The utilisation of small and low-grade coal Improvements by suitable preparation for market—Economy in use—By-product recovery—Economies possible from centralised systems of power generation: from extended use of carbonised coal, including gas—Low temperature carbonising schemes.

William Ripper, D.Eng., D.Sc., Professor of Engineering, University of Sheffield, "Works Organisation and Efficiency." Three Lectures.

April 23, 30, May 7.

Cantor Lectures.

Monday afternoons, at 4.30 p.m. :—

Professor A. Beresford Pite, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

January 29, February 5, 12, 19.

Juvenile Lectures.

Wednesday afternoons, January 3 and 10, at 3 p.m. :—

Alan A. Campbell Swinton, F.R.S., "Electricity and its Applications." Two Lectures.

FOTHERGILL LECTURES.

The Fothergill Lectures on "Surveying, Past and Present," by Edward A. Reeves, F.R.A.S., F.R.G.S., Map Curator and Instructor in Surveying to the Royal Geographical Society, have been reprinted from the *Journal*, and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

A full list of the Lectures which have been published separately, and are still on sale, can also be obtained on application.

MECHANICAL MILKING.

In reference to the statement on this subject in Engineering Notes in the *Journal* of October 27th, Sir Philip Magnus put a question on November 2nd, to the Secretary to the Board of Agriculture, asking whether attention had been called to the alleged advantages of substituting the mechanical milking of cows for hand milking; if so, whether the Board had considered the practicability of the proposal; and whether he was aware of the effect of the adopting of mechanical milking in removing many difficulties with which railway companies had to contend and in facilitating the carriage of milk by earlier morning trains.

Mr. Acland, in reply, said:—"The Board have for years given close attention to this subject, and are well aware of the advantages to be derived through the use of milking machines under suitable conditions. Farmers generally are also pretty well aware of the advantages and disadvantages of the machine compared to hand milking, though there is a good deal of difference of opinion as to what is the best machine. Trials of different machines have been conducted under the Board's auspices at farms attached to agricultural colleges, and wide inquiry has been made as to the results of the use of machines in practice. Many farmers having large and medium-sized herds are finding it an advantage to instal machines at the present time, but generally there is not much saving of time effected by their use, and therefore the point as to catching earlier trains which the hon. member raises does not arise."

It may be added that mechanical milking is largely employed in Holland, and that it has been found very useful in Australia and America. In this country opinion as to its value is divided. Some dairy farmers have been very successful with it, but others, after trying it, have abandoned its use. It does not entirely supersede hand milking, as the udder is not quite emptied and has to be "stripped" by hand. It also appears to affect the teats, in some cases at all events.

ARTS AND CRAFTS.

The Arts and Crafts Exhibition at Burlington House (Second Notice).

The present Arts and Crafts Exhibition shows a healthy blending of old and new ideals. The Committee have arranged a small but interesting retrospective room, the President of the Society has written a spirited preface to the catalogue which compares certainly to no disadvantage with similar forewords in the earlier catalogues, and the old custom of holding lectures in the galleries has been revived under the rather more modern guise of papers followed by discussion. On the other hand, the grouping of a portion of the exhibits under such headings as Domus, University, Ecclesiastic, Municipal, Hall of Heroes, is quite a new departure, and so is the practice of allowing different schools of art to be responsible for a certain amount of space. The plan tried some years ago (on one occasion only) of allowing some members of the Society to

group their own exhibits together has this year been extended so that certain artists, or bands of artists, are responsible for the decoration and furnishing of what are practically small rooms. With regard to the effect of the exhibition as a whole, it would be difficult to say too much for the general architectural and decorative planning of Ecclesiastic, with its chapels decorated by Mr. Wilson, Mr. Louis Davis and others, and held together by its general scheme of decoration and by the frieze around the dome contributed by Mr. C. W. Whall. The appearance again of the Hall of Heroes is fine, with its walls adorned with paintings by well-known artists, its dainty figures by Sir G. Frampton in the apse and its general air of spaciousness and grandeur; but when one passes on to the neighbouring rooms one is tempted to wonder whether the feeling of roominess which is so delightful in the large hall has not been rather dearly bought at the expense of the overcrowded rooms on either side of it. University, which contains not only Mr. W. Rothenstein's fine decoration, "designed as a memorial to members of the English universities who have served in the war," but also a large composition by Mr. Augustus John, suffers rather from being used to house a somewhat miscellaneous collection of exhibits—not all of which accord very well with the title of the gallery. The little room in which are shown the work of the students of the embroidery class at the Royal College of Art, if not very remarkable, houses a pleasing and homogeneous little collection of work, but the exhibit of the Birmingham school hardly seems to justify its existence. There is some good student metalwork and some embroidery which is creditable as the work of girls of fifteen and sixteen, but there seems no particular reason for showing it at an exhibition at Burlington House.

Jewellery and Metalwork.—When we turn to the individual works, the jewellery and small metalwork are amongst the most interesting exhibits, and this is due in no small measure to the President's own work. Mr. Wilson's jewellery is always individual, distinguished and planned with real decorative feeling. He shows a whole caseful of jewellery and some specimens of silversmithing as well, amongst which a beautiful silver chafing-dish is worthy of special notice. Mr. Stabler, again, is represented by a good set of his wonderfully fine champlevé enamel, and some silverwork. The mace for Westminster Cathedral, however, which is his most important exhibit of enamel and metalwork combined, is rather unnecessarily heavy looking, even for a mace, though there is some excellent workmanship in it. Mr. Paul Cooper has some distinctive jewellery, some of it recalling Scandinavian enamelwork, and some beautiful silverwork and shagreen. Mr. C. R. Ashbee's exhibits include a good silver porringer, whilst some of Mr. Edward Spencer's work shows a happy combination of silver and ivory. Mr. James Cromar Watt's cup with cover in silver, enamel moonstone and crystal is rather Eastern in feeling and on quite different lines from most of the silverwork. Mr. and Mrs. Gaskin have sent some good jewellery, and Miss Kirkman, Miss Ramsay and a number of other women are adequately represented. On the whole both the metalwork and jewellery reach a very high level. There is little struggling after originality at all costs, and yet the work of the different craftsmen is easy to distinguish. The jewellers, too, for the most part have ceased to rely too exclusively on the colour and beauty of their stones, and are seeking to provide at the least beautiful and fitting setting—in many cases ornament only dependent in a minor degree on stones and enamel.

Textiles.—The embroidery is at once very interesting and a trifle disappointing. There is quite a good deal which is fresh up to a certain point, very little which shows much real originality. The most striking piece of work is Miss Newill's banner for the Birmingham Church Congress, which represents S. Martin dividing his cloak with the beggar. This is well and boldly schemed. Its main outlines are well pronounced and to be seen from a distance (a very important matter in a banner), and the workmanship bears the closest investigation. There is not a very great quantity of large embroidery, and some at least of what there is hardly justifies itself—it could have been done at any rate almost as well by machine as by hand; but there is some beautiful cutwork, a little good lace and a fair sprinkling of samplers Needlework pictures are fairly well represented. A good deal of the design harks back to the sixteenth, seventeenth and eighteenth centuries, and there are some good examples of embroidery in black or black and some colour on white in the old style. Mrs. E. W. Newberry's work, which is amongst the most beautiful in the exhibition, is inspired by Eastern originals. Her cushions, mainly in terra-cotta and black on unbleached coloured linen, suggest the old work which comes from the Greek islands, and her tablecloth worked in silk of many colours in plait stitch of some sort which covers the entire ground suggests that it had a fine piece of Eastern embroidery for its model. Mrs. W. Sickert's dalmatic is a bold piece of work which was shown at Ghent. There is a great deal of tasteful stitchery of a simple kind adapted to the ornamentation of clothes—some of it following more or less the fashions of the day, some adorning jerkins or tunics rather suggestive of the Balkans. A little elaborate weaving is shown and some tapestry, but the woven fabrics in the main consist of simple hand-woven stuffs remarkable on the whole for their beautiful colouring.

Amongst these may be mentioned Miss Mairet's work and Miss Inez Skrine's handwoven silk and mercerised cotton bedspreads, one in rose and gold, the other in blue and green, in which good use has been made of extra shuttles at the ends.

Writing, Illumination and Book Production.—The writing and illumination and allied crafts are mainly shown in one room, though Mrs. Sydney Cockerell's beautiful illuminations—the finest work of the kind in the exhibition—are on view in the retrospective room. There are not so many rolls of honour and war memorials as might have been expected, but Mr. Graily Hewitt exhibits—as well as a number of beautifully-written books and the Consecration prayer in gilt on parchment in the form of an altar cross—the roll of honour for St. Stephen's Club. Mrs. Louise Powell shows some good illumination, and Mr. Allan Vigers' frieze in a neighbouring room is wonderfully reminiscent of his illumination work. Mr. Kruger shows some good designs for printing and Mr. Noël Rooke an interesting certificate. The finest bookbindings are by Miss Katharine Adams, some of them quite old friends. The Doves Press and other printers have sent excellent examples of their typography, but there is not very much which bears on book production for the world at large.

Woodwork, Pottery and Design.—Furniture is one of the features of the exhibition. Mr. Gimson's chair in walnut and bone, designed as a study for a set to be executed in ebony and ivory for S. Andrew's Chapel in Westminster Cathedral, is interesting and unusual. Mr. Romney Green's walnut adjustable chair with folding table is good to look at and suggests the height of comfort and practicality. Mr. Laurence Turner's mirrors, especially the one in ebony inlaid with mother-of-pearl and ivory, are real works of art. There are not very many toys, but Mr. Macdonald Gill's animal alphabet blocks ought to rejoice the heart of any child.

The pottery includes a good show of Martin stoneware and some of Mrs. Stabler's charming little figures, as well as some cases of painted work by various people all very much of the same type. There is some beautiful lustre by the Pilkington Tile and Pottery Co.—amongst it some wonderful pieces of colour—but it is not very well shown. Messrs. Powell's case of glass is delightfully refined and delicate.

Designs for wallpapers, textiles and the like are rather to seek. Either the Society has looked coldly upon such work or the designers have not felt encouraged to send. Amongst those that are shown may be mentioned Mr. Horace Warner's Jay birds, which is attractive without being too obtrusive, and Mr. Edgar Pattison's Warsaw which, though rather aggressive in colour, is well designed and in its way interesting.

NOTES ON BOOKS.

La Science Française. Paris: Ministère de l'Instruction publique et des Beaux-Arts. 1915.

The French Ministry of Public Instruction contributed to the San Francisco Exhibition a Scientific Library of books ancient and modern, intended to illustrate the share taken by France in the development of science. This collection of scientific books is illustrated by the present publication, which is meant to summarise the work with which the collection dealt.

The term science covers in France a wider scope than in this country, where it is generally considered to include only those branches of natural knowledge to which the work of the Royal Society is specially devoted. These two volumes, therefore, besides including mathematics, astronomy, physics, chemistry, geology, biology, medicine, and geography, contain articles on philosophy in general (by M. Henri Bergson), sociology, the science of education, archæology, history, art, and economics. For the most part natural science proper is included in the first volume, while the second volume treats not only many of the subjects above mentioned, but also contains chapters on English, Italian, Spanish, and French literature as studied in France.

The chapter "Les études anglaises," by M. Émile Legouis, is extremely interesting; but it hardly does justice to the influence exercised in former years on French literature by that of England. While English writers of the seventeenth century were to a very large extent influenced, or even dominated, by their French contemporaries and predecessors, it should be remembered that in the eighteenth century the current flowed in the opposite direction. During the whole century the published writings of French philosophers, important as they were, were in fact but the development of ideas started by English philosophers. That this was so was probably due to a large extent to Voltaire, who while he was in England studied Newton's "Principia," and indeed introduced our great English mathematician to France. Voltaire's philosophy, too, was almost wholly based on Locke's teaching, though it owed something also to the writings of Hobbes. Rousseau also learned much from the former philosopher, though he was to a much greater extent a follower of Hobbes, while Montesquieu's model in his "Esprit des Lois" was the English Constitution—hence indeed its popularity in England. Voltaire's followers, Diderot and d'Alembert, learned much from England. D'Alembert in his Discours Préliminaire to the "Encyclopédie" founded his description of human knowledge

on Bacon; while Palissot, one of the adversaries of the "Encyclopédie," characterised the whole work as a "servilement copié de Bacon." Théry also says, "C'est le Novum Organum de Bacon qui inspira a Diderot ses Pensées sur l'Interprétation de la Nature." Condillac carried Locke's doctrines on to pure materialism; indeed it is not too much to say that the doctrines which led eventually to the French Revolution had their entire source and origin in the ideas which originally started and developed in the freer atmosphere of this country.

Other English writers also, nearer the end of the eighteenth century, for instance Gibbon and Adam Smith, had a considerable influence in France, and were greatly studied in that country. The whole question, however, is too large a one for discussion in a chapter on the "Study of English Literature in France," and perhaps it was hardly to be expected that M. Legouis should have given much attention to it.

Taking the book on the whole, it is an extremely interesting and valuable synopsis of the work which Frenchmen have done towards the advancement of human knowledge, and the idea of its publication was a very happy one.

DYEING IN GERMANY AND AMERICA. By S. H. Higgins, M.Sc. Second Edition. Manchester: At the University Press; London: Longmans, Green & Co. 5*s*. net.

The first edition of this book was issued in 1907 as "a Report . . . on the results of a Tour in the United States of America and Germany in 1905–1906," and the author's intention was to give a general survey of the dyeing and allied industries of these countries. Although no further visit has been paid to either of these countries, the author's subsequent nine years' experience as a demonstrator in the Dyehouse of the Manchester School of Technology and as a works chemist and manager has enabled him to add materially to what appeared in the first edition, and the work now serves as a very complete and compendious text-book which should prove useful, not only to the technical student, but also to the general reader who desires to obtain some knowledge of the dyeing industry.

The question of producing dyes in this country has been so acute since the outbreak of the war that most readers will turn at once to the last chapter, in which Mr. Higgins discusses the present situation. He appears to take a sane and moderate view of it. Although the aniline dye industry had passed into the hands of Germany, he points out that this is only a relatively small part of the total chemical industry of any country, and he claims that, with the exception of synthetic dye-stuffs, synthetic drugs, and fine chemicals, the English chemical industry has held its own. "As for the German colour industry," he writes, "I have long contended that it has too often provided food for those Britishers who are always stating that we are falling behind in the industrial race, and the fact that this industry is again brought to our notice only serves to point to the paucity of more suitable material to brood over. Even though the dividends declared by the German colour-works are high, it must be remembered that there are still many English chemical concerns which are the envy of German manufacturers."

Of course it would be foolish to attempt to belittle the importance of the German industry. Mr. Higgins does full justice to this, and he sums up the various reasons for its value very shrewdly. It has been a great industrial asset to Germany, he writes, "because it has become the mother of many new industries, such as synthetic pharmaceutical products, anhydrosulphuric acid, and liquid chlorine; because the industry has been a great object-lesson to the Germans in showing the advantage derived from the application of science to industry; because it has reacted in producing a more general appreciation of technical education; and because it has been an important factor in inducing the Government and local authorities to render assistance in fostering various industries."

Whether the German dye industry will ever recover the position which it occupied before the war remains to be seen. Steps have been taken by several other countries, notably Great Britain, France, the United States of America, Russia, and Japan to render themselves independent in this respect of the German factories; and it seems highly improbable that the world at large will ever again permit itself to suffer from the monopoly of a people whose commercial methods are now seen to be but little better than its barbarous methods of carrying on war.

GENERAL NOTES.

BELGIAN WOUNDED AND PRISONERS OF WAR.—The Belgian Committee of the "Oeuvre Internationale pour Blessés et Prisonniers de Guerre," propose to hold at Breda (Holland) an exhibition of paintings and drawings for the benefit of prisoners of war in Germany. Prizes will be offered, varying in value from 500 francs and a gold medal to 75 francs and a bronze medal; and the paintings and drawings will become the property of the Committee, who will dispose of them by sale or lottery for the benefit of the Belgian wounded and prisoners of war. All taking part in the competition must send in their work to the Committee, 17, Willemstraat, Breda, Holland, before January 1st, 1917.

VICTORIA AND ALBERT MUSEUM.—A collection of Chinese porcelain, chiefly of the latter part of the Ming dynasty (1368-1643), lent by the Rev. J. F. Bloxam, has been placed on exhibition in the Victoria and Albert Museum. Three cases contain "blue and white," illustrating the rich and varied qualities of colour attained in this class of ware by the Chinese potters of the sixteenth century. The intense "Mohammedan blue" of the reign of Chia Ching (1522-1566), composed in part of cobalt imported from Western Asia, is seen at its best on a large bulbous bowl with figure-subjects in panels, on a square-bodied bottle with gourd-shaped neck charmingly painted with groups of children in garden scenes, and on several covered boxes of various shapes. The beauty of these is equalled by that of the finest porcelain of the reign of Wan Li, approximately synchronising with the lifetime of Shakespeare; the blue is of a soft dark hue verging on indigo, under a bluish-toned glaze of wonderful silky smoothness. Examples of this Wan Li blue are two small plates with the figure of Shou-lao, god of longevity, seated in a landscape surrounded by various attributes; another plate, exquisitely painted with a bird on a peach-tree, should also be noticed. A cylindrical brush-pot with figure subjects exemplifies the light greyish-blue imitated by the Japanese potters of Hirado, which is recorded to have characterised the porcelain of the reign of Hsüan Tê (1426-1435). Another rare piece is a bottle with a formal design of lotus-flowers and Arabic inscriptions, made for Moslem use, dating in all likelihood from the time of Chêng Tê (1506-1521), whose name it bears.

NEWFOUNDLAND SEALING.—The Newfoundland sealing season of 1916, which has just ended, was financially the most successful experienced for years. The catch numbered 243,000, according to *United Empire*, and the value to the fishermen is returned at £200,000. In consequence of the war, and the absence of men to handle the ships, the number of vessels engaged was only twelve—the smallest number employed for many years; but this was counteracted by the large catch that was secured, as well as by the high prices prevailing for the proceeds of the fishery.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 13...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. E. T. Hall, "Dulwich History and Romance."

Brewing, Institute of (London Section), Imperial Hotel, Russell-square, W.C., 7.30 p.m. Mr. S. O. Nevile, "The Formation of War Savings Associations in Breweries."

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Address by the President.

East India Association, Caxton Hall, Westminster, S.W., 4.15 p.m. Mr. B. A. Collins, "Co-operation in India."

TUESDAY, NOVEMBER 14...Swiney Lectures, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. J. S. Flett, "The Mineral Resources of Europe." (Lecture I.)

Asiatic Society, 22, Albemarle-street, W., 4 p.m. Mr. J. Kennedy, "The Gospels of the Infancy, the Lalita Vistara and the Vishnu Purâna: or, the Interchange of Legends between India and the West."

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 8 p.m. Mr. I. Beaumont, "My Six Months' Travels in Italy."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Address by the President.

Anthropological Institute, in the Theatre of the Civil Service Commission, Burlington-gardens, W., 6 p.m. (Huxley Memorial Lecture.) Sir James G. Frazer, "Ancient Stories of a Great Flood."

Colonial Institute, Hotel Cecil, Strand, W.C., 8.30 p.m. Sir Rider Haggard, "Empire Land Settlement."

WEDNESDAY, NOVEMBER 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Opening Meeting of the 163rd Session. Address by Dr. Dugald Clerk, Chairman of the Council, on "The Stability of Great Britain."

Meteorological Society, 70, Victoria-street, S.W., 5 p.m. 1. Mr. C. E. P. Brooks, "A Meteorologist in China." 2. Lieut. A. E. M. Geddes, R.E., "The Storm of the 11th-13th November, 1915, in its Passage over the British Isles."

Microscopical Society, 20, Hanover-square, W., 8 p.m. 1. Dr. C. Singer, "The Microscopic Work of the Accademia dei Lincei." 2. Mr. S. C. Akehurst, "A New Tank and Pond-weed Holder for use with Greenough Immersion Objectives."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Lecture by Professor Walter de la Mare.

THURSDAY, NOVEMBER 16...Swiney Lectures, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. J. S. Flett, "The Mineral Resources of Europe." (Lecture II.)

Linnean Society, Burlington House, W., 5 p.m. 1. The General Secretary, "(*a*) Pedanios Dioscorides of Anazarba; his writings and his commentators; (*b*) The new cabinets for the Linnean herbarium." 2. Dr. A. B. Rendle, "A new Australian genus of Hydrocharidaceæ." 3. Mr. A. W. Waters, "Some collections of the littoral marine Fauna of the Cape Verde Islands, made by Cyril Crossland, M.A., in the summer of 1904.—Bryozoa."

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. F. Young, "The Camera-Pilgrim's Progress."

Historical Society, 22, Russell-square, W.C., 5 p.m. Mr. W. Foster, "The India Board."

Numismatic Society, 22, Albemarle-street, W., 6 p.m.

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 5.30 p.m. Informal Meeting.

FRIDAY, NOVEMBER 17...Swiney Lectures, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. J. S. Flett, "The Mineral Resources of Europe." (Lecture III.)

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Report of the Hardness Tests Research Committee.

CONTRIBUTIONS TO THE READING-ROOM.

The Council have to acknowledge, with thanks to the Proprietors, the receipt of the following Transactions of Societies and other Periodicals.

TRANSACTIONS, ETC.

Aëronautical Society, Journal.
African Society, Journal.
American Academy of Arts and Sciences, Proceedings.
American Chemical Society, Journal.
American Institute of Architects, Journal.
American Institute of Electrical Engineers, Transactions.
American Institute of Mining Engineers, Transactions.
American Leather Chemists' Association, Journal.
American Philosophical Society, Proceedings and Transactions.
American Society of Civil Engineers, Transactions.
American Society of Mechanical Engineers, Journal.
Architectural Association, Journal.
Auctioneers' and Estate Agents' Institute, Record.
Australasian Association for the Advancement of Science, Report.
Australian Official Journal of Patents.
Bagnères-de-Bigorre, Société Ramond, Bulletin.
Barrow and District Association of Engineers, Transactions.
Bath and West of England Society, Journal.
Bombay, Royal Asiatic Society, Journal.
British Association for the Advancement of Science, Report.
British Dental Association, Journal.
British Fire Prevention Committee, Publications.
Canada, Royal Society, Proceedings and Transactions.
Canadian Patent Office, Record.
Canadian Society of Civil Engineers, Transactions.
Central Chamber of Agriculture, Journal.
Chartered Institute of Patent Agents, Transactions.
Chemical Society, Journal.
Chicago, Field Museum of Natural History, Publications.
———, Western Society of Engineers, Journal.
Cleveland Institution of Engineers, Proceedings.
Cold Storage and Ice Association, Proceedings.
Concrete Institute, Transactions.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Geneva, Société des Arts, La Revue Polytechnique
Geological Society, Quarterly Journal.
Geologists' Association, Proceedings.
Glasgow, Royal Philosophical Society, Proceedings.
Haarlem, Koloniaal Museum, Bulletin.
Imperial Arts League, Journal.
Imperial Department of Agriculture for the West Indies, Publications.
Imperial Institute, Bulletin.
India, Geological Survey, Memoirs and Palæontologia Indica.
Indian Meteorological Department, Monthly Weather Review.
Institute of Bankers, Journal.
Institute of Brewing, Journal.
Institute of British Carriage Manufacturers, Journal.
Institute of Chemistry, Proceedings.
Institute of Metals, Journal.
Institute of Sanitary Engineers, Journal.
Institution of Automobile Engineers, Proceedings.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Civil Engineers of Ireland, Transactions.
Institution of Electrical Engineers, Journal.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Gas Engineers, Transactions.
Institution of Mechanical Engineers, Journal and Proceedings.
Institution of Mining and Metallurgy, Transactions.
Institution of Municipal and County Engineers, Proceedings.
Institution of Naval Architects, Transactions.
Institution of Petroleum Technologists, Journal.
Iron and Steel Institute, Journal.

Japan Society, Transactions and Proceedings.
Johannesburg, Chemical, Metallurgical and Mining Society, Journal.
Junior Institution of Engineers, Record of Transactions.
Kew Gardens Bulletin.
Kyoto, Imperial University, Memoirs of the College of Science.
Lima, Ministerio de Fomento, Boletin.
Linnean Society, Journal.
Lisbon, Sociedade de Geographia, Boletim.
Liverpool, Engineering Society, Transactions.
———, Literary and Philosophical Society, Proceedings.
Lyons, Société d'Agriculture, Sciences et Industrie, Annales.
Manchester Literary and Philosophical Society, Memoirs and Proceedings.
———, Municipal School of Technology, Journal.
——— Steam Users' Association, Reports.
——— Textile Institute, Journal.
Michigan Academy of Science, Reports.
Milan, Associazione Elettrotecnica Italiana, Atti.
———, Collegio degli Ingegneri ed Architetti, Atti.
National Indian Association, "The Indian Magazine and Review."
National Physical Laboratory, Collected Researches.
New South Wales, Royal Society, Journal and Proceedings.
New York Academy of Sciences, Annals and Memoirs.
North-East Coast Institution of Engineers and Shipbuilders, Transactions.
Norwich, Operative Brewers' Guild, Journal.
Nova Scotian Institute of Science, Transactions.
Paris, Comité International des Poids et Mesures Procès Verbaux.
——, Conservatoire National des Arts et Métiers, Annales.
——, Société d'Encouragement pour l'Industrie Nationale, Bulletin.
——, Société de Géographie Commerciale, Bulletin
——, Société des Ingénieurs Civils, Mémoires.
——, Société Internationale des Electriciens, Bulletin.
——, Société Nationale d'Acclimatation de France, Bulletin.
Patent Office, Illustrated Official Journal.
Pennsylvania (Western), Engineers' Society of, Proceedings.
Philadelphia, Academy of Natural Sciences, Proceedings.
———, Engineers' Club, Proceedings.
Physical Society, Proceedings.
Quekett Microscopical Club, Journal.
Royal Agricultural Society, Journal.
Royal Asiatic Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Canadian Institute, Transactions.
Royal Cornwall Polytechnic Society, Annual Report.
Royal Dublin Society, Proceedings and Transactions.
Royal Horticultural Society, Journal.
Royal Institute of British Architects, Journal.
Royal Institution of Great Britain, Proceedings.
Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal and Record.
Royal National Life Boat Institution, "The Life-Boat" and Annual Report.
Royal Sanitary Institute, Journal.
Royal Scottish Society of Arts, Transactions.
Royal Society, Philosophical Transactions and Proceedings.
Royal Society of Edinburgh, Transactions and Proceedings
Royal Statistical Society, Journal.
Royal United Service Institution, Journal.
St. Louis Engineers' Club, Journal.
Smithsonian Institution, Report and Publications.
Society of Antiquaries, Archæologia and Proceedings.
Society of Architects, Journal.
Society of Biblical Archæology, Proceedings.
Society of Chemical Industry, Journal.
Society of Dyers and Colourists, Journal.
Society of Engineers, Transactions.
South African Association for the Advancement of Science, Report.
South Wales Institute of Engineers, Proceedings.
Tokyo, Imperial University, Journal of the College of Science.
Tramways and Light Railways Association, Journal.
Victoria Institute, Journal of the Transactions.
Washington, National Academy of Sciences, Proceedings.
Wisconsin Academy of Sciences, Transactions.

JOURNALS.

Weekly.

Amateur Photographer.
American Gas Light Journal.
American Machinist.
Architect.
Auto-Motor Journal.
Board of Trade Journal.
Bradstreet's.
British Journal of Photography.
Builder.
Building News.
Cabinet Maker.
Chemical News.
Chemist and Druggist.
Chronicle (Montreal).
Colliery Guardian.
Contractors' Record.
Economist.
Electrical Engineering.
Electrical Industries.

Electrical Review.
Electrician.
Electricity.
Engineer.
Engineering.
English Mechanic.
Gardeners' Chronicle.
Grocer.
Indiaman.
Indian Engineering.
Iron and Coal Trades Review.
Journal of Agricultural Research (Washington).
Journal of Gas Lighting.
Kinematograph.
Lancet.
Leather.
Life (New York).
London County Council Gazette.
London Teacher.
Machinery.
Machinery Market.
Mechanical Engineer.
Mechanical World.
Medical Press and Circular.
Mining Journal.
Mining World (Chicago).
Model Engineer and Electrician.
Motor Traction.
Musical Standard.
Nature.
Notes and Queries.
Page's Weekly.
Pharmaceutical Journal.
Photography.
Pitman's Journal.
Practical Engineer.
Produce Markets' Review.
Public Opinion.
Sanitary Record.
Saturday Review.
Science.
Scientific American.
Shipping World.
Spectator.
Surveyor.
Syren.
Textile Mercury.
Work.

Fortnightly.

Agricultural News (Barbados).
Finance Chronicle.
Jeweller and Metalworker.
Junior Mechanics and Electricity.
Madrid Cientifico.
Perak Government Gazette.
Revue Générale des Sciences.
West India Committee Circular.

Monthly.

Acetylene Lighting and Welding Journal.
Analyst.
Arms and Explosives.
Automobile Engineer.
Board of Agriculture Journal.
Bookseller.
Brewers' Journal.
British Esperantist.
British Trade Journal.
Cassier's Engineering Monthly.
Chamber of Commerce Journal.
Cold Storage and Ice Trades Review.
Commercial Education.
Concrete.
Construction (Toronto).
Co-partnership.
Cotton (Atlanta).
Decorator.
Dyer and Calico Printer.
Educational Times.
Engineering Magazine.
Engineering Review.
Ferro-Concrete.
Gas and Oil Power.
Geographical Journal.
Geographical Review (New York).
Giornale del Genio Civile (Rome).
Horological Journal.
Ice and Cold Storage.
Illuminating Engineer.
Imperial Colonist.
International Sugar Journal.
Investor's Monthly Manual.
Journal of Department of Agriculture of Victoria.
Leather Trades' Review.
Marine Engineer.
Master Builder.
Mercantile Guardian.
Miller.
Mining Magazine.
Moniteur Scientifique.
Musical Times.
Mysore Economic Journal.
Paper Maker.
Paper Makers' Monthly Journal.
Philosophical Magazine.
Photographic Journal.
Plumber and Decorator.
Popular Science Monthly (New York).
Pottery and Glass (New York).
Pottery Gazette.
Power User.
Propriété Industrielle (Berne).
Science Abstracts.
Scottish Geographical Magazine.
Secretary.
Steamship.
Studio.
Symons's Meteorological Magazine.
Textile Manufacturer.
Textile Recorder.
United Empire.
Watchmaker, Jeweller, and Silversmith.
Water and Water Engineering.
Wireless World.

Quarterly.

Agricultural Journal of India.
Botanical Journal.
Colonial Journal.
Edinburgh Review.
Quarterly Review.
West Indian Bulletin.

NEWSPAPERS.

African Mail.
British Australasian.
Canadian Gazette.
Ceylon Observer (Overland Edition).
Englishman (Calcutta).
Home and Colonial Mail.
London and China Telegraph.
London Commercial Record.
Madras Weekly Mail.
Newcastle Weekly Chronicle.
Pioneer Mail (Allahabad).
South Africa.
Times of Ceylon (Weekly Summary).
Times of India (Overland Weekly Edition).

The issue of many of the Publications formerly received by the Society has been interrupted by the War, and their names have been temporarily removed from this list.

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